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NORTHERN VIGOUR OF STRAWBERRY CROWNS AND GARLIC

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Northern Vigour of Strawberry Crowns and Garlic: Initiation of Commercialization into Domestic and Foreign Markets, Research and Industry Agrologists Training

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1.0 ABSTRACT

The Northern Vigour[®] response in strawberries (*Fragaria* x *ananassa* Duch.) and garlic (*Allium sativum* L.) is clearly environmentally-regulated. Therefore, it is important to examine this effect over a long period of time. With the changing climate particularly over the past several years, not surprisingly, this response has also been variable. Nevertheless, if 'Camarosa' crown material is undamaged by fall frost during harvest, California strawberry fruit growers will likely produce larger fruit in the first 2 months (and potentially throughout the production season) using Saskatchewan-grown crowns. If climate returns to more normal patterns, early yield may also be more consistently observed. Saskatchewan crown producers may save labour costs by avoiding de-blossoming. In addition, net crown yield may increase since smaller previously discarded crowns may be used without compromising subsequent fruit yield. Tissue culture production is promising and hopefully, Saskatchewan will eventually develop its own cultivars for export. In terms of domestically grown strawberries for fruit production, crown material such as 'Kent' or dayneutral strawberry production for local fruit production is possible but requires: appropriate harvest time and availability of coolers 0 to -2C.

With new import tariffs on garlic ($1.85/kg, Waterer, pers.comm.), garlic production in Saskatchewan appears more promising. Allicin and alliin levels of Saskatchewan-grown garlic were competitive with U.S.-sources but was cultivar-dependent and dependent upon location of production within Saskatchewan. When grown in Saskatoon, medicinal components were enhanced over La Ronge-grown bulbs within the same cultivar. Between cultivars, certain types were also better utilized for fresh vs. processing as well as storage. The Saskatoon location produced the highest quality planting material compared to La Ronge. Adequate adaptation of garlic to a specific location is also an important consideration to fulfill yield potential. Thermotreatment of garlic plantlets in tissue culture was the best all-round technique for micropropagation. Unless extraction and phytomedicinal processing industries are developed, it would be difficult to develop a strong phytomedicinal garlic industry in this province. Present pharmaceutical companies are largely vertically integrated with their own garlic production sites.

2.0 EXECUTIVE SUMMARY

The present project examines the potential Northern Vigour[®] response in strawberries (*Fragaria* x *ananassa* Duch.) and garlic (*Allium sativum* L.) with the primary objective to develop Saskatchewan as a supplier of high quality, superior –yielding planting material for national and international markets. Twelve greenhouse and field studies were conducted on a budget that was reduced by 50% to $140,000 over a four year period. The project coordinated research between five U.S. cooperators and up to nine Canadian sites. 'Camarosa' crowns were mass produced and tested in both northern and southern regions of the province for 'Northern Vigour[®]' potential. In addition, timing of harvest, the influence of hormonal application and sizing of crowns on subsequent yield and the use of tissue culture as a means of increasing both crown and runner production was examined. The local cultivar 'Kent' and B.C. cultivars were studied to determine if Saskatchewan could supply crowns locally for spring planting. Garlic was produced for further testing in the USA, cultivar comparisons under Saskatchewan conditions, evaluated medicinal components, tested tissue culture as a method for obtaining virus-free stock and tested the storage period and seedling vigour in garlic.

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a) Strawberry crowns

Over a 7 year period, Canadian-sourced crowns out-performed California-sourced crowns in each year from at least one Canadian-sourced location. Since the highest prices of marketable fruit occur in these first 2 months, early yield will be of advantage to California producers. However, this early yield response was variable. In the first 3 years of observation, Canadian-sourced crowns consistently expressed higher yields in the first two months of marketable fruit production. In the following 2 years, results were more variable depending upon Canadian source and U.S. location of fruit production. In the most recent 2002 fruiting year, yields from Canadian-sourced crowns were again consistently higher than California-sourced crowns. Total yields at the end of the season were not consistently higher than California-sourced crowns and in the majority of cases, was lower than the U.S.-sourced crowns. Since the northern vigour phenomenon is environmentally-regulated, it is important to continue to profile yield response over a number of years. Simple accumulation of total chilling hours is not directly related to total yield but may be more important to advancement of flowering.

By contrast over a 5 year period, mean fruit size of Saskatchewan-sourced crowns was generally larger than California-sourced crowns both in the first 2 months and by the end of the season, particularly from the Outlook, SK location. Fruit size was larger by an average of 7.8% in the first 2 months of harvest and by an average of 6.9% higher by the end of the season. High variation in results prevented detection of significant differences in some locations.

Flowering time was generally advanced the later the harvest date. This is consistent with our other observations where increased crown exposure to chilling requirement induced higher marketable fruit yield in the first 2 months of harvest.

Cytokinin treatment either as a crown soak or soil drench was not effective and was toxic to the crowns in spite of the wide range in concentrations tested. Tissue culture treatment may be the only effective method to enhance runnering and daughter crown production using this hormone treatment. De-blossoming does not appear to positively impact daughter production. Therefore, de-blossoming may not be necessary. Similarly crown sizes ranging from a mean of 0.8 to 1.6 cm in diameter did not influence any of the parameters tested.

Production of crowns for domestic markets is potentially viable and will likely result in increased crown quality through a reduced incidence of disease. However, several factors should be addressed: appropriate harvest time in the fall to ensure sufficient chilling has been received by the crowns before harvest; overwintering the crowns and harvest in the second year of production to increase crown yields; selection of locations of crown production based on optimizing daughter yield and not simply based on latitude; selection of cultivars for crown production; ensure appropriate (0 to –2C) and stable temperature storage conditions.

A website was developed which contains photographs of planting, harvesting equipment as well as trimming sheds. Our progress and final reports are also accessible through this site. Field days and talks have also provided some information. To provide greater awareness of crown production, growers have been contracted to produce strawberry crowns on a small scale for ADF 20010051. In addition, one of our strawberry plots is at the Agri-Arm Spoke site in Rosthern which if expanded to other spoke sites, should be an effective way to demonstrate strawberry crown production. However, if this industry is to be successful, a coordinated effort between extension, marketing, customs and CFIA, human resource and research personnel is required.

b) Garlic

A significant cultivar-dependent response was determined on SK-sourced bulbs subsequently grown in California. Certain cultivars originating in Saskatchewan (e.g. M&M Garlic) and grown in the

U.S. out-performed the U.S.-adapted cultivars. Conversely, U.S.-adapted cultivars did not perform well under Saskatchewan conditions in year one but became adapted after 3 years of continuous growth in Saskatchewan.

Saskatchewan has potential to be competitive with U.S.-grown cultivars for allicin and alliin content if those cultivars are adapted to Saskatchewan-growing conditions and are grown in-province. Chinese cultivars expressed high levels of both alliin and allicin. High alliin levels did not correspond with high allicin levels. Therefore, the allinase activity should be tested in future.

In general, significant differences in mean bulb weight, bulb diameter and total bulb yields among cultivars were noted. These differences contributed to main effects of cultivar, location of origin and also the interaction between the two factors. California-late Stiff, M&M and DWG generally tend to produce larger cloves and higher bulb yield compared to other cultivars. It appears that cloves originating from La Ronge tend to have an increased bulb size, but bulbs originating from Saskatoon tend to produce higher bulb yield than La Ronge-sourced material

M & M garlic purchased from Dave & Krista McBain, of Whitefox, and California late-Stiff are superior to the other cultivars in terms of size and weight. This variety would be useful for processing since it has few cloves with ample amounts of flesh. AWG and Getz may be useful for the fresh market due to the large number of cloves, however, clove size was relatively small. LWG, CL, CE and DWG may be more desirable since these cultivars produce an adequate number of cloves while maintaining their weight, providing a slightly larger bulb and clove to the consumer. The Chinese cultivars were not superior to any of the Saskatchewan or California cultivars tested in terms of agronomic yield components, however, our other tests indicate superior alliin and allicin content.

Generally, no clear benefit to leaf number or plant height was observed with storage greater than 10 weeks. Cultivars CE and CL had the greatest plant heights and leaf numbers. CL also had the greatest number of cloves, however, they were significantly smaller in comparison to other cultivars. Adapted CE and CL may be the cultivars of choice to keep in storage. Optimum duration of storage under cool temperatures are cultivar-dependent but also depend upon which parameters are of most importance to the grower. Vegetative growth (leaf number, plant height) have a shorter storage threshold than parameters of cloving, bulb and clove weight which are enhanced after 22 weeks in storage.

Rooting in tissue culture was easy to induce in all garlic cultivars under all treatments. Bulbing was also easily induced in culture but not under low temperature conditions. CE and CL were multiplied in culture more easily under more treatments compared to the other cultivars. Thermotreatment appears to be the best all-round technique for certain cultivars.

Table 2.1 Summary of marketable strawberry fruit yield over a 7 year period from 1996-2002 and comparison between California-sourced and Saskatchewan-sourced strawberry crowns

Fruit Production Year	California Location of Fruit Production	Source of Crowns	Marketable Yield kg/ha (lbs/acre)			
			Jan. + Feb.	+/- %	Total	+/- %
1996	Irvine, California (South Coast Research Station)	Norcal, CA	11,480 (10,221)		115,369* (102,718)	
		La Ronge, SK	16,766 (14,927)	+69%	124,974 (111,269)	+11%
1997	Irvine, California (South Coast Research Station)	Norcal, CA	6,422 (5,718)		97,297* (86,627)	
		Saskatoon, SK	7,388 (6,578)	+15%	107,697 (95,887)	+11%
		La Ronge, SK	9,036 (8,045)	+40%	110,937 (98,771)	+14%
1999	Nakama Ranch, Oxnard, CA.	Lassen Canyon, CA	4,724 (4,208)		45,360** (40,409)	
		La Ronge, SK	5,788 (5,157)	+23%	53,386 (47,559)	+18%
2000	Nakama Ranch, Oxnard, CA.	Fall River, CA	8,245 (7,341)		15,724*** (14,000)	
		Ile a la Crosse, SK	7,086 (6,310)	-16%	11,618 (10,344)	-35.3%
		Outlook, SK	7,857 (6,996)	-5%	13,746 (12,239)	-14.4%
		La Ronge, SK	8,207 (7,307)	-0.5%	13,918 (12,392)	-13.0%
	Mandalay Farms, Oxnard, CA	Fall River, CA	6,993 (6,226)		60,995* (54,306)	
		Outlook, SK	8,932 (7,953)	+22%	60,427 (53,800)	-.01%
		La Ronge, SK	6,348 (5,652)	-10%	51,831 (46,147)	-15%
	Ito Farms, Orange County, CA	Lassen Canyon, SK	10,245 (9,121)		28,342*** (25,234)	
		Ile a la Crosse, SK	11,169 (9,945)	+9%	26,519 (23,611)	-6.9%
		Outlook, SK	9,968 (8,875)	-2.8%	25,026 (22,281)	-13.3%
		La Ronge, SK	9,141 (8,138)	-12%	24,865 (22,138)	-14.0%
2001	Nakama Ranch, Oxnard, CA.	Norcal, CA	6,473 (5,763)		13,631**** (12,136)	
		La Ronge, SK	5,769 (5,136)	-12.2%	10,442 (9,297)	-23.4%
	Ito Farms, Orange County, CA	Lassen Canyon, CA	7,598 (6,765)		16,517*** (14,706)	
		Meadowlake, SK	9,226 (8,214)	+21.4%	16,045 (14,286)	-2.9%

		Outlook, SK	6,194 (5,514)	-22.7%	12,883 (11,471)	-22.0%
		Manning, AB	4,955 (4,411)	-53.3%	10,901 (9,706)	-34.0%
		Fairview, AB	7,267 (6,470)	-4.6%	13,874 (12,353)	-16.0%
		Fort Vermillion, AB	6,194 (5,514)	-22.7%	12,223 (10,882)	-26.0%
2002	Ito Farms, Orange County, CA	Lassen Canyon, CA	7,373 (6,564)		35,528*** (31,632)	
		La Ronge, SK	8,227 (7,325)	+11.6%	22,594 (20,116)	-36.4%
		Meadowlake, SK	9,795 (8,721)	+32.8%	32,520 (28,953)	-8.5%
		Outlook, SK	8,619 (7,674)	+16.9%		
		Manning, AB	7,966 (7,093)	+8.0%	27,426 (24,419)	-22.9%
		Fairview, AB	8,489 (7,559)	+15.1%	26,120 (23,256)	-26.5%
		Fort Vermillion, AB	7,313 (6,512)	-0.8%	27,948 (24,884)	-21.4%
		Carajou, AB	7,314 (6,511)	-0.8%	27,818 (24,767)	-21.4%

+/- represents the percentage above or below California-sourced crowns.

Fruit yield to June 30; **Fruit yield to May 30; ***Fruit yield to April 11; ****Fruit yield to March 31.

Table 2.2 Summary of marketable fruit size and comparison between California-sourced and Saskatchewan-sourced strawberry crowns.

Fruit Production Year	**California Location of Fruit Production**	**Source of Crowns**	**Mean Fruit weight (g/fruit)**			
			Jan. + Feb.	+/- %	End of season	+/- %
1996	Irvine, California (South Coast Research Station)	Norcal, CA	36.3		28.5	
		La Ronge, SK	37.6	+3.6%	29.2	+2.5%
1997	Irvine, California (South Coast Research Station)	Norcal, CA	34		28	
		Saskatoon, SK	32	-6.2%	29	+3.5%
		La Ronge, SK	35	+3%	29	+3.5%
2000	Nakama Ranch, Oxnard, CA.	Fall River, CA	38.9		34.0	
		Ile a la Crosse, SK	35.9	-8.4%	32.6	-4.3%
		Outlook, SK	41.0	+5.4%	39.2	+15.3%
		La Ronge, SK	44.3	+13.9%	33.8	-0.6%
	Mandalay Farms, Oxnard, CA	Fall River, CA	33.7		26.0	
		Outlook, SK	40.6	+20.5%	24.6	-5.6%
		La Ronge, SK	39.1	+16.0%	26.1	+0.4%
	Ito Farms, Orange County, CA	Lassen Canyon, SK	31.3		29.7	
		Ile a la Crosse, SK	33.7	+7.7%	31.7	+6.7%
		Outlook, SK	35.0	+11.5%	34.0	+14.5%
		La Ronge, SK	33.7	+7.7%	30.5	+2.7%
2001	Nakama Ranch, Oxnard, CA.	Norcal, CA	48.6		39.2	
		La Ronge, SK	44.1	-10.2%	41.6	+6.1%

+/- represents the percentage above or below California-sourced crowns.

3.0 PROJECT BACKGROUND

The production advantages of vegetatively propagated crops such as potatoes grown in northern latitudes compared to southern sources has long been known by potato growers in Europe and North America. Studies conducted by the Department of Horticulture Science at the University of Saskatchewan demonstrated that the relative vigour and yield potential of seed potatoes produced in Saskatchewan were superior to those from the USA. This relative phenomenon has been termed 'Northern Vigour®'. It has led to enhanced export markets for Saskatchewan-grown seed potatoes.

Preliminary studies conducted at the University of Saskatchewan, in cooperation with the University of California, Davis, USA indicated that California strawberry cultivars grown in higher latitudes (LaRonge, Saskatchewan) produced daughter plants were ready for new planting 2-3 weeks earlier than those supplied from mountainous regions in California and that subsequently out yielded those supplied from mountainous regions in California by 40 – 60% in the first three months. Chandler *et al.* (1989) reported that Florida growers who purchase Californian cultivars from Canadian producers' experience earlier fruiting than the same cultivars purchased from local Florida producers. Presently, the majority of strawberry crown requirements for both the growing Saskatchewan U-Pick industry and

Florida markets is supplied by the Nova Scotia strawberry industry. Production of an earlier Saskatchewan – grown daughter crowns has the potential to satisfy export markets in southern California.

Yield trials conducted by the Department of Horticulture Science at the University of Saskatchewan have demonstrated that garlic could be successfully grown in Saskatchewan. Since the production industry of garlic has yet to be established to meet the local demand, Saskatchewan continues to import approximately 31,000 kg of garlic annually, mostly from China, Mexico and Jamaica.

If it can be demonstrated that Saskatchewan-grown garlic and strawberries are superior to those grown in southern latitudes, Saskatchewan has a good opportunity to become a garlic 'seed' (clove) and strawberry crown producer and exporter because of its disease-free environment as well as 'Northern Vigour®' potential.

4.0 General objectives

The quality of seed source for vegetatively propagated crops plays a vital role in yield and location has a central role in seed quality. Vegetatively propagated crops such as potatoes produced in Saskatchewan are significantly more productive than those produced at southern latitudes in the USA. This phenomenon has been termed 'Northern Vigour®' and has opened a major export market for Saskatchewan-grown potatoes. The present project will determine the potential 'Northern Vigour®' response in other vegetatively propagated crops such as strawberries (*Fragaria* x *ananassa*) and garlic (*Allium sativum*) with the ultimate objective to develop Saskatchewan as a supplier of high quality, superior-yielding planting material for national and international markets. Furthermore, Saskatchewan has the potential to provide strawberry crowns to California before other USA suppliers and thereby catch the earliness of the markets.

PROJECT ACTIVITIES

A) STRAWBERRY CROWNS (*Fragaria* x *ananassa* Duch.)

Study 5.0: Mass Production of Strawberry Cultivar 'Camarosa' in Northern Regions of Saskatchewan

5.1 Objective: To propagate, harvest 'Camarosa' crowns in northern regions of Saskatchewan and ship down to southern California for fruit yield performance.

5.2 Materials and Methods :

'Camarosa' is a June-bearing cultivar, chosen for its high-yielding capabilities and wide acceptance within the California market. Previous studies indicated LaRonge, Saskatchewan (55°.07' N Latitude) produces superior yielding crowns, therefore this location was chosen for the mass production study. Research was conducted at the Saskatchewan Agriculture and Food research plots courtesy of Gerry Ivanochko, an Agrologist with Saskatchewan Agriculture and Agri-Food. Soil nutrient analysis was conducted after splitting the total plot area into two sections according to soil type. One area consisted of the lower 1/3 of the field with soil types ranging from a sandy loam to a sandy soil. The second area consisted of the upper 2/3 with soil type varying from a sandy loam to a clay soil. Both areas had a pH ranging from 5 – 7. Soil analysis performed by Enviro-Test Laboratories – Plains Innovative Laboratory

Services, indicated deficiencies in NO_3-N, P, K and SO_4-S in the upper 2/3 of the total plot area. The lower 1/3 of the area was found to be deficient in NO_3-N and SO_4-S while K and P levels were found to be marginal. Fertilizer was applied prior to planting.

5.2.1 1998 Crown production season

12,000 'Camarosa' crowns were planted on June 4th & 5th, 1998, utilizing a two-seater strawberry planter. Crowns were planted 30cm apart within rows with a 1.5m spacing between rows to allow for mechanical plot maintenance. The research plot was maintained following the recommended cultural practices for the region with irrigation occurring throughout the season as necessary. Harvesting occurred during September 29th to the 1st of October, where mother crowns averaged 5 daughters per plant. Crowns were dug using a small potato harvester and placed into plastic bags for transport to Saskatoon 1998 (Figs. 5.2, 5.3). Trimming of the strawberry crowns occurred at the Agriculture Greenhouses on the University of Saskatchewan campus. A total of fifteen people were employed to trim, count and package the strawberry crowns for shipment in 1998. A total of 24,000 daughter crowns were processed and boxed. Prior to shipping, an application for *Export Inspection and Phytosanitary Certification* was made to Agriculture Canada: Food Production and Inspection Branch. Inspection occurred on October 5th, 1998 and certificates were received indicating that the crowns were certified for export. Shipping occurred on October 6th via courier to Nakama Ranch, c/o Mr. Chas Nakama in Oxnard, California (34°12'N 119° 00' W) where plants were tested against strawberry crowns produced at Lassen Canyon nurseries in Redding, CA (40° 06' N 122° 40'W).

Mr. Nakama did not receive crowns until the 9th of October, 1998 without cold storage due to problems in transit (USDA and DHL World Wide Courier). Crowns arrived at a temperature of 72°F. This may have impacted the results. Mr. Nakama collected data and visual observations with yield sampling on 16,000 plants to compare the LaRonge crown yield to the California-crown yields from January to June, 1999.

5.2.2 1999 Crown Production Season

Six hundred 'Camarosa' strawberry crowns were planted in La Ronge, Saskatchewan (Lat. 55°. 07' N) at the Potato Lake research plots on the 1st of June 1999. Plot area provided by Gerald Ivanochko of Saskatchewan Agriculture and Food with plot maintenance provided by Sandy Maybin, University of Saskatchewan Research Technician.

Fertilizer was applied prior to planting according to soil analysis performed by Enviro-Test Laboratories – Plains Innovative Laboratory Services. Nitrogen was brought up to 100lbs/acre and potassium was increased to 450 lbs./acre. Crowns were planted 0.3m apart within rows with a 1.5m spacing between rows to allow for mechanical plot maintenance. The research plot was maintained following the recommended cultural practices for the region with irrigation occurring throughout the season as was deemed necessary. Harvesting occurred during September 27th until the 30th. Crowns were dug using a small potato harvester (Fig. 5.2), trimmed and packaged at the La Ronge site (Fig. 5.11). On average La Ronge produced 5 daughters per mother crown. On October 6th one thousand crowns from La Ronge were shipped to each cooperator via courier: Nakama Ranch, c/o Mr. Chas Nakama in Oxnard, California; B & E Farms, c/o Mr. Bill Ito in Westminster, CA and to Mandalay Berry Farms, c/o Mr. John Dallum also of the Oxnard, CA area.

As a comparison, two hundred fifty crowns were planted at Ile a la Crosse, Saskatchewan (55°.23' N) courtesy of Gerald Ivanochko, Agrologist, Saskatchewan Agriculture and Agri-Food and at Alvena, Saskatchewan (52°.25' N) courtesy Larry Mullen. Planting occurred during the first week of June. The research plots were maintained following the recommended cultural practices for the region. Crowns in Alvena didn't grow well due to a high soil pH of 8.5. The soil was modified and positive plant growth occurred, however, it was too late in the season for adequate runners to be produced. Plants were mulched. Plant material at Ile a la Crosse was harvested during the last week of September, trimmed and packaged. The strawberry plants averaged three daughters per mother at this location. On October 6th two hundred twenty five crowns were shipped via courier to each cooperator; Nakama Ranch, c/o Mr. Chas Nakama in Oxnard, California and Ito Farms, c/o Mr. Bill Ito in Westminster, CA.

5.2.3 2000 Crown Production Season

Six hundred 'Camarosa' strawberry crowns were planted in La Ronge, Saskatchewan on the 29th of May 2000. Planting at this site was delayed due to wet and cold weather. Fertilizer was applied prior to planting according to soil analysis recommendations provided by Enviro-Test Laboratories – Plains Innovative Laboratory Services. Crowns were planted 30cm apart within rows with a 1.5m spacing between rows to allow for mechanical plot maintenance. The research plot was maintained following the recommended cultural practices for the region with irrigation occurring throughout the season as necessary. Due to cool and wet weather throughout the entire summer, productivity was very low. Only 1-2 daughters were produced per mother (Fig. 5.1), and it was therefore decided not to include these crowns within the tests for that season. 'Camarosa' crowns from the Peace River District of Alberta (Fairview and Manning) were also grown and sent to Saskatoon for joint shipment with Saskatchewan crowns to Orange County, California at Ito Farms (Bill Ito and Steve Ozawa, Irvine, CA).

Five hundred fifty crowns were planted at Ile a la Crosse, Saskatchewan (55°.23' N) courtesy of Gerald Ivanochko, Agrologist, Saskatchewan Agriculture and Agri-Food and at Good Soil, Saskatchewan (52°.25' N) courtesy Brenda Lange.

Planting in Ile a la Crosse occurred on May 31st, 2000. The research plots were maintained following the recommended cultural practices for the region. Crown production was low due to cool and wet summer conditions and therefore crowns were not harvested. This environment decreased runner production that in turn affected the subsequent daughter formation.

In Good Soil (Meadowlake), Saskatchewan a total of 213 strawberry crowns were planted on two planting dates, May 20th and 26th, 2000. Soil analysis was performed prior to planting by Enviro-Test Laboratories – Plains Innovative Laboratory Services. The soil was deficient in nitrogen and marginal in potassium and sulfur. Fertilizer was added prior to planting as a 1:1 part of 30-10-10 and 7-7-0 (blood bone meal). A solution of 15-30-15 was used on the plant material for the first three waterings following planting. Harvesting occurred during the first week of October 2000. One hundred crowns were trimmed and shipped to Ito Farms (Bill Ito, Westminster, CA) for further evaluation. Hourly temperatures were also calculated. In August, 83 chilling hours accumulated, while in September, 222 chilling hours accumulated for a total of 305 chilling hours. By contrast, the Outlook plant material accumulated only 110 chilling hours.

On October 16th a thousand crowns were shipped to each cooperator via courier to Nakama Ranch, c/o Mr. Chas Nakama in Oxnard, California and Ito Farms, c/o Mr. Bill Ito in Westminster, CA. Marketable fruit yield data were collected and compared to California-sourced plant material.

For the Outlook and Ile a la Crosse sites, 772 and 212 plants were planted at Ito Farms, respectively. As a comparison, 2316 California sourced 'Camarosa' crowns from California were sampled at Ito Farms.

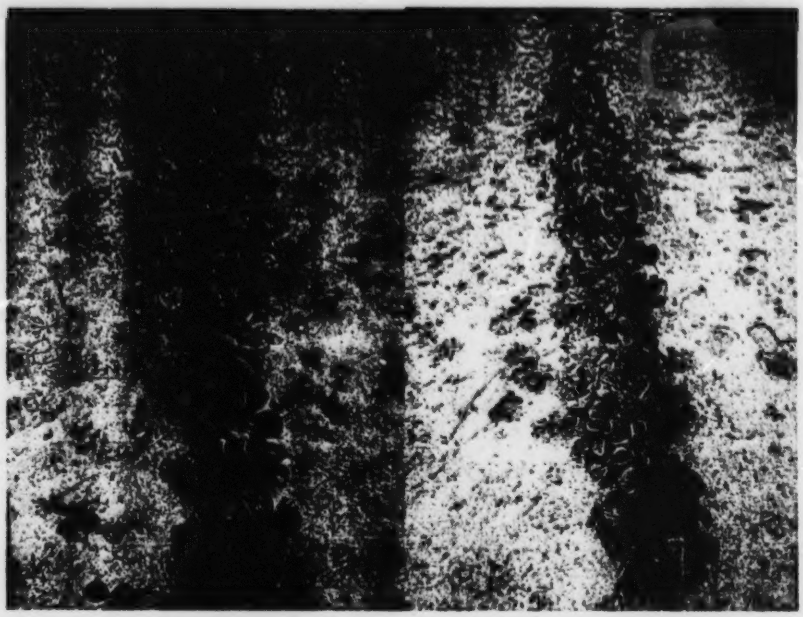


Figure 5. 1 'Camarosa' strawberry plants in La Ronge Saskatchewan, Aug. 31, 2000.

5.2.4 2001 Production Season

Two hundred and fifty crowns were planted at each of the following locations in Saskatchewan: Saskatoon (May 28), Goodsoil (near Meadowlake) (June 2&3), and La Ronge (June 2). The Meadowlake location applied Remay field cover at the time of planting. Field covers were removed on August 22. In Alberta, the following locations were shipped 250 crowns: Fairview, Manning, Fort Vermillion and Carajou. One hundred crowns from each site were shipped via courier to Ito Farms, Orange county, CA (Bill Ito and Steve Ozawa).

5.2.5 2002 Production Season

Since the northern vigour phenomenon is environmentally regulated, it is important to continue to obtain long-term data on California fruit yield response to Saskatchewan-grown crowns. Therefore, two hundred and fifty crowns were again planted at each of the following locations in Saskatchewan: Nipawin, Meadowlake, Edenwold (near Regina). Hay River (NWT) and Rosthern (Seager Wheeler Farm, Agri-Arm site). The 2002 spring season was unseasonably cool and planting at all sites (except Edenwold which planted on May 18) occurred between May 25-31. Since the final report is due before the results of the California 2003 fruit yield data will be available, those fruit yield results will be combined with the ADF grant # 20010051 .

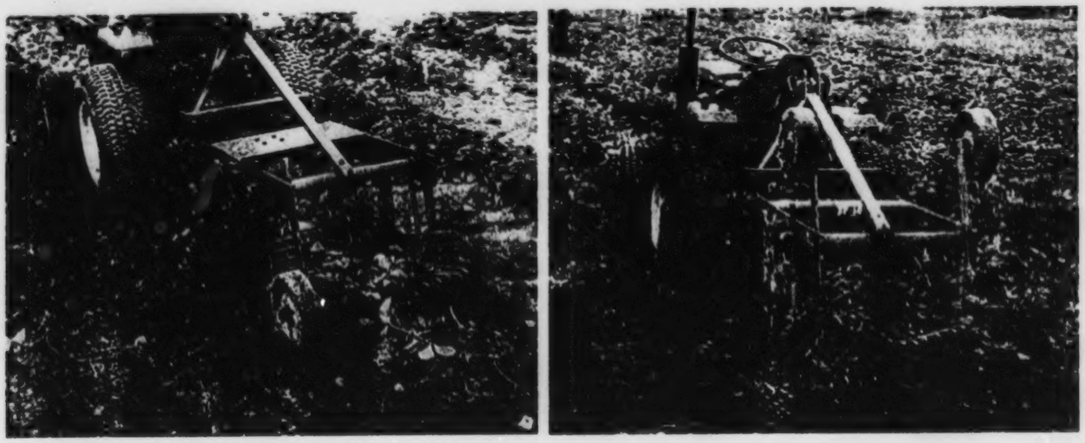


Figure 5.2 Small potato harvester used to dig the strawberry crowns.

Figure 5.3 Field workers picking the strawberry crowns up after being dug and placing them into plastic bags for transport to Saskatoon

Figure 5.4 Sandy Maybin -Technician of the La Ronge location (left) and Gerald Ivanochko with Dr. Karen Tanino (right) are holding daughter crowns to be shipped to Oxnard, California USA

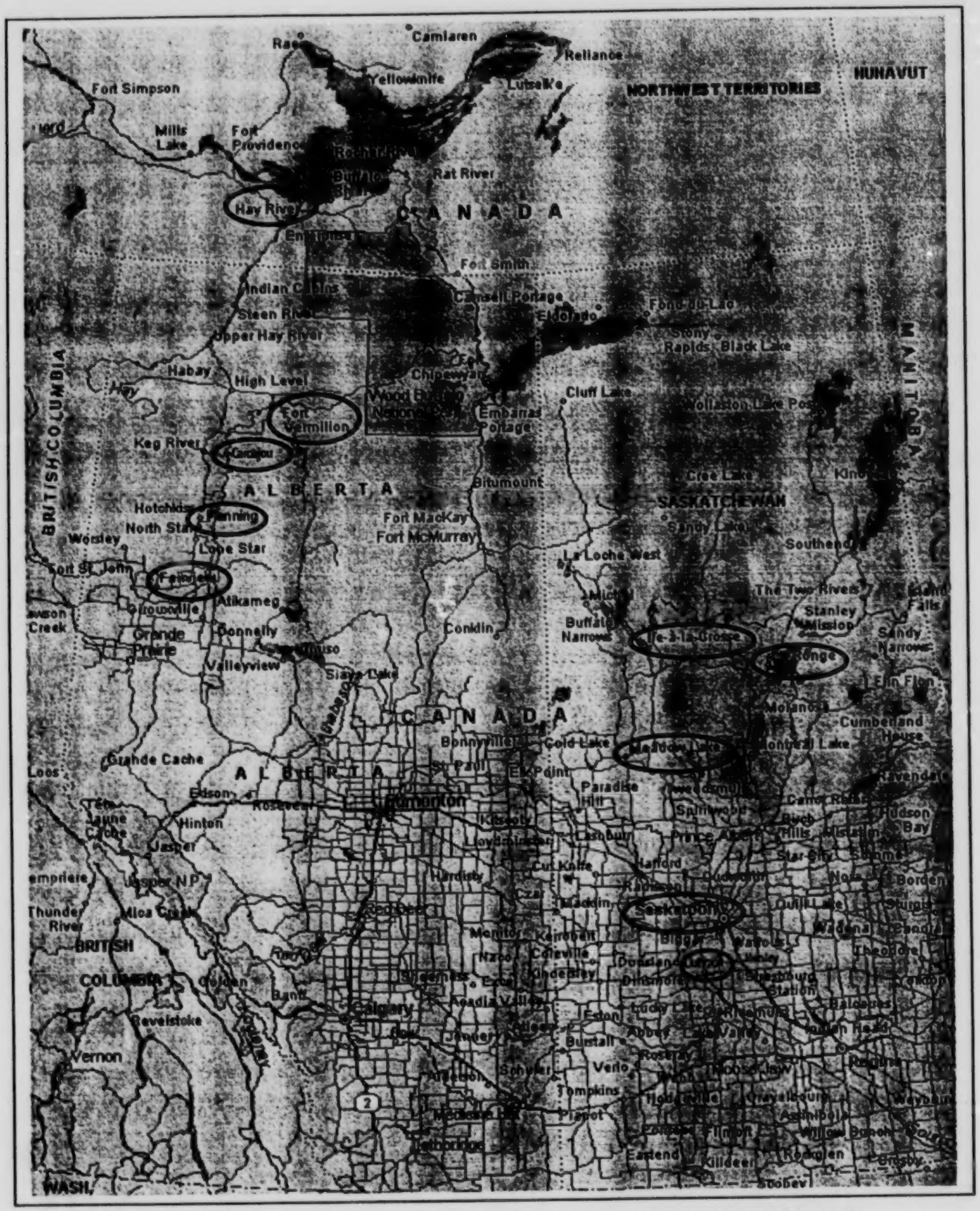
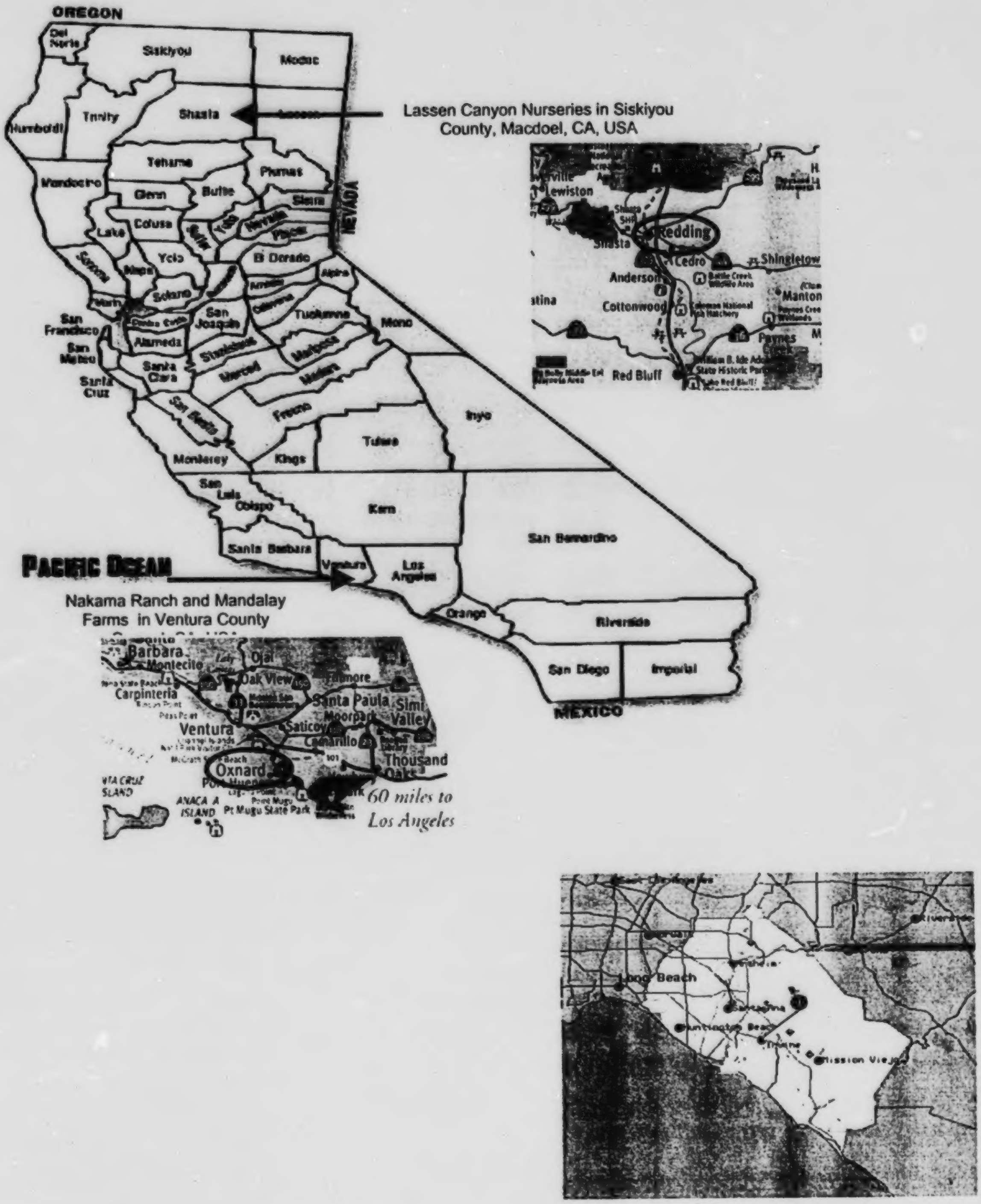

Camlaren
Reliance
Yellowknife
Lutselk'e
NORTHWEST TERRITORIES
NUNAVUT
Fort Simpson
Mills Lake
Fort Providence
Rat River
Hay River
CANADA
Fort Smith
Indian Cabins
Steen River
Upper Hay River
Fond-du-Lac
Stony Rapids
Black Lake
MANITOBA
Habay
High Level
Fort Vermilion
Wood Buffalo National Park
Embarras Portage
Cluff Lake
Wollaston Lake Post
Keg River
Carcajou
BRITISH COLUMBIA
ALBERTA
Bitumount
Cree Lake
SASKATCHEWAN
Hotchkiss
Manning
North Star
Worsley
Lone Star
Fort MacKay
Fort McMurray
Sandy Lake
Southend
Fort St. John
Fairview
La Loche West
Atikameg
Michel
The Two Rivers
Stanley Mission
Creek
Grande Prairie
Donnelly
Valleyview
Conklin
Buffalo Narrows
Ile-a-la-Crosse
La Ronge
Sandy Narrows
Slave Lake
Flin Flon
CANADA
Cumberland House
Bonnyville
Cold Lake
Meadow Lake
Montreal Lake
Grande Cache
ALBERTA
St. Paul
Elk Point
Paradise Hill
Spiritwood
Prince Albert
Birch Hills
Hudson Bay
Edson
Edmonton
Hinton
Jasper
Jasper N.P.
Lloydminster
Hanford
Star City
Saskatoon
Wadena
Thunder River
Mica Creek
BRITISH COLUMBIA
Golden
Banff
Calgary
Kindersley
Dundurn
Strasbourg Station
Revelstoke
Vernon
Medicine Hat
Lethbridge
Tompkins
Piapot
Eastend
Killdeer
Moose Jaw
Regina
WASH.

Figure 5. 5 Canadian Locations of 'Camarosa' strawberry crown production (circled in red)


OREGON
NEVADA
MEXICO
PACIFIC OCEAN
Siskiyou
Modoc
Shasta
Lassen
Trinity
Humboldt
Del Norte
Tehama
Plumas
Mendocino
Glenn
Butte
Sierra
Colusa
Lake
Yolo
Sonoma
Napa
Solano
El Dorado
Alpine
San Francisco
San Mateo
Alameda
Santa Clara
Santa Cruz
San Joaquin
Tuolumne
Mono
Stanislaus
Merced
Mariposa
Madera
San Benito
Fresno
Inyo
Monterey
Kings
Tulare
San Luis Obispo
Kern
San Bernardino
Santa Barbara
Ventura
Los Angeles
Orange
Riverside
San Diego
Imperial
Redding
Lewiston
Shasta
Anderson
Cottonwood
Cedro
Shingletown
Manton
Red Bluff
Barbara
Montecito
Carpinteria
Ojai
Oak View
Fillmore
Santa Paula
Simi Valley
Moorpark
Ventura
Saticoy
Camarillo
Thousand Oaks
Oxnard
Port Hueneme
Pt Mugu State Park
60 miles to Los Angeles
Long Beach
Riverside
Anaheim
Santa Ana
Huntington Beach
Irvine
Mission Viejo

Lassen Canyon Nurseries in Siskiyou County, Macdoel, CA, USA

Nakama Ranch and Mandalay Farms in Ventura County

Figure 5.6 Location of Lassen Canyon Nurseries, Fall River Nurseries, Norcal Nurseries (suppliers for California-sourced plant material) and the testing location of Nakama Ranch, Mandalay Farms and Ito Farms in California.

Figure 5. 7 Temperatures in the shipping containers were 23°C at the time of arrival at the Nakama Ranch in Oxnard, California, USA

5.3 Results

5.3.1 1998 Crown Production, 1999 Fruit Production year

Mr. Nakama did not receive the crowns until the 9th of October and the plant material was without cold storage due to problems in transit (USDA and DHL World Wide Courier). A temperature of 23°C was recorded within the shipping containers upon arrival. Crowns had broken dormancy during transit with one leaf having emerged with long etiolated petioles. The cooperator was not willing to plant the crowns, as past experience had proven that the crowns would die if planted out in this condition. However, the grower decided to plant the crowns and data was collected. The results however, may have been impacted as a result of the shipping conditions (Fig. 5.7).

Mr. Chas Nakama of Nakama Ranch planted the La Ronge (Canadian) strawberry crowns on October 13th, 1998. As a comparison Lassen Canyon (USA) strawberry crowns were dug on the 6th of October 1998 and planted on the 13th for yield comparisons. Data was collected by Mr. Chas Nakama and Jean Nakama of Nakama Ranch from the field plots (Figs. 5.8, 5.9). Yields were collected from the 18th of January 1999 until the 17th of May 1999 (Table 5.1). Crowns from La Ronge, Saskatchewan are producing higher yields than California crowns over the duration of the growing season (Table 5.1). Data also indicates crowns from La Ronge, Saskatchewan are producing higher initial yields than California crowns during the period of January 18th until January 30th, 1999 (Table 5.1) where for the first month, Saskatchewan crowns were yielding 65% above the Californian crowns. Overall, Saskatchewan crowns produce 17.7% more fruit than Californian plant material. Yields increased steadily with time throughout the sampling period (Table 5.1).

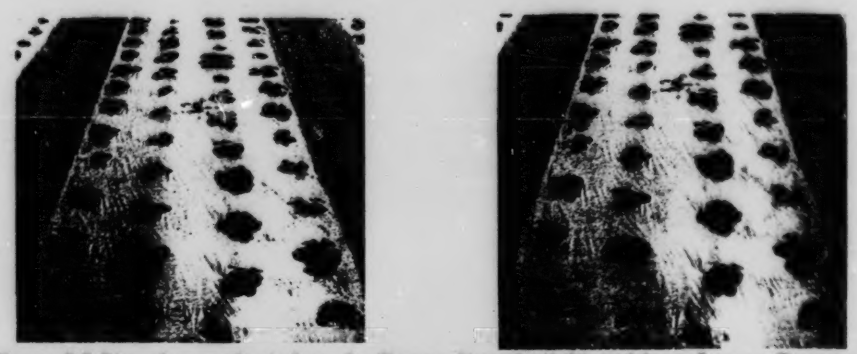


Figure 5.8 Strawberry plants from La Ronge, Canada (left) and from Lassen Canyon, USA (right) planted at the Nakama Ranch in Oxnard, California

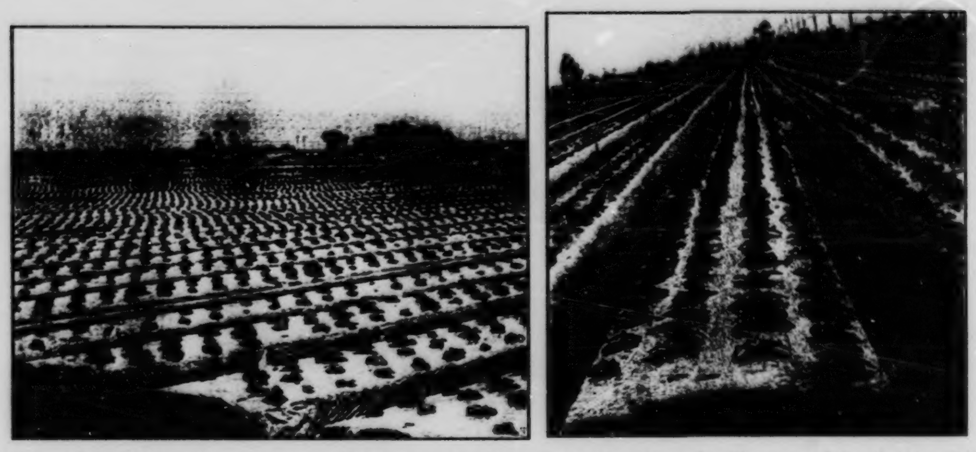


Figure 5.9 California strawberry fields consist of mounded fumigated soil covered in plastic with perforations for the strawberry crowns

Table 5.1 Comparison of total fruit yield in kg/ha (pounds) based on California-sourced versus Saskatchewan-sourced crowns for the end of January, February, March, April and May harvest periods, 1999 at Nakama Ranch

Origin	January	February	March	April	May	Overall Yield
La Ronge, Canada.	1,471	4,317	7,725	18,045	21,948	53,386
	(1,311)	(3,846)	(6,882)	(16,076)	(19,552)	(47,559)
Lassen Canyon, USA	896	3,828	6,958	14,643	19,039	45,360
	(798)	(3,410)	(6,199)	(13,045)	(16,961)	(40,409)
% ± of Cal plants	**+65.0%**	**+12.7%**	**+11.0%**	**+23.2%**	**+15.3%**	**+17.7%**

Environmental data was collected from all original sources of 'Camarosa' crowns (La Ronge and Lassen Canyon) and from the production-testing site (Oxnard, CA). The environmental data for La Ronge and Lassen Canyon Nurseries (Macdoel, CA) consisted of hourly temperature logs to determine the amount of chilling which occurred prior to shipping to the testing location. La Ronge, SK. data was collected with a data logger located at the growing site. Data for Macdoel, CA was obtained from a weather station of Tulelake, CA (Fig. 5.6) through the national weather service (NOAA). In spite of the increased yield advantage of La Ronge-sourced crowns, the chilling received in August and September was below that of Tulelake. It is unknown whether the pre-sprouting of crowns advanced yield production.

Table 5.2 indicates the number of chilling hour achieved for La Ronge during the months of August and September was 124 hours in 1998. The chilling hours at the Tulelake ranger station was 157.

Table 5.2 Accumulated chilling hours (°C) in 1998 collected at the originating nursery locations in La Ronge, SK and in Tulelake, CA (Siskiyou County, CA)

Origin	August	September	Total Chilling Hours
Tulelake, California	51	106	157
La Ronge, Canada.	9	115	124

5.3.2 1999 Crown Production, 2000 Fruit Production year

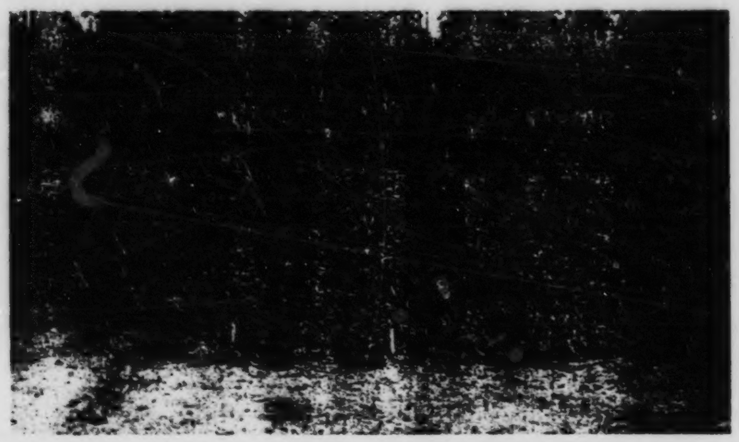


Figure 5.10 'Camarosa' strawberry plot in La Ronge, Saskatchewan.

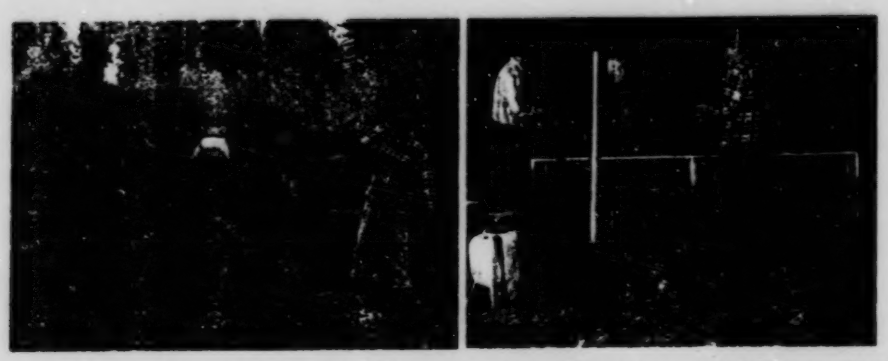


Figure 5. 11 Harvesting and trimming of 'Camarosa' strawberry crowns in La Ronge, Saskatchewan

5.3.2.1 Nakama Ranch

When yields are compared on a percentage basis with the California-sourced plant material as the base line, the La Ronge, SK-sourced plant material is out-produced by the Fall River crowns from California in each month except February (Table 5.3). In February, La Ronge site expressed a 19.8% elevated yield and rendering a – 0.5 % yield in January and February compared to Fall River plants (Table 2.1). By contrast in the previous year, the first two months, marketable yield from La Ronge was + 23.0 % higher than California-sourced crowns (Table 2.1). Ile a la Crosse did not perform well compared to Fall River-sourced crowns in any of the sampling months tested. Unlike the previous year, in the 1999 crown production year, crowns were not pre-sprouted and chilling hours received was again lower than Fall River-sourced plants (Table 5.5).

Table 5.3 Comparison of 'Camarosa' yields kg/ha (pounds/acre) at Nakama Ranch (Oxnard, CA) originating from La Ronge and Ile a la Crosse SK. compared to California 'Camarosa' from Fall River (McArthur, CA) in 2000.

Origin	January	February	March	April	Overall Yield
Fall River, CA	4,804 (4,277)	3,441 (3,064)	5,211 (4,640)	2,266 (2,017)	15,724 (14,000)
Ile a la Crosse, Canada	3,973 (3,538)	3,113 (2,772)	3,058 (2,723)	1,473 (1,311)	11,618 (10,344)
% ± of Cal plants	**-17.32%**	**-9.53**	**-41.[illegible]**	**-35.00%**	**-26.11**
La Ronge, Canada.	4,086 (3,638)	4,121 (3,669)	3,898 (3,471)	1,813 (1,614)	13,918 (12,392)
% ± of Cal plants	**-17.5%**	**+ 19.8%**	**-33.7%**	**-25.0%**	**-13.0%**

5.3.2.2 Mandalay Berry Farms

Forty plants for each of the locations (Fall River, CA and La Ronge, SK.) were planted at Mandalay Berry Farms for yield testing. Yield data from this site was collected during the co-operators normal harvesting cycle from December 27th to June 24th, 2000 (Table 5.4).

As a percentage comparison using the California 'Camarosa' as the base line indicates that the California 'Camarosa' started producing the earliest in December (Table 5.4). It was not until the February harvesting period that the plants from La Ronge started producing +17.04% and +22.79% above the California 'Camarosa' for the months of February and March respectively. This resulted in a net elevated yield from December to March of + 6.5 %. However, from April to June, the yields continued to decrease to –12.56% and –8.23% for April and May below the California 'Camarosa' resulting in an overall decrease in total marketable yield of -15%.

Chilling hours received in Canadian-sourced crowns were lower than the California-sourced crowns for the 1999 production year (Table 5.5). The unusually warm fall recorded for the 1999 year in Saskatchewan likely contributed to the lower early yields.

Table 5.4 Yield kg/ha (pounds/acre) comparisons of La Ronge and Outlook, SK-grown strawberry crowns to 'Camarosa' crowns grown at Fall River Nursery in McArthur, CA at the Mandalay Berry Farms testing site from December 1999 to June 2000.

Origin	Dec.	Jan.	Feb.	Mar.	April	May	June	Overall Yield
La Ronge, Canada.	0 (0)	2,123 (1,890)	4,225 (3,762)	9,102 (8,104)	8,880 (7,906)	25,457 (22,665)	2,054 (1,829)	51,831 (46,147)
Fall River,, USA	97 (86)	3,383 (3,012)	3,610 (3,214)	7,412 (6,600)	10,156 (9,042)	27,740 (24,698)	8,596 (7,653)	60,995 (54,306)
% ± of Cal plants	**-100%**	**-37.31%**	**+17.04%**	**+22.79%**	**-12.56%**	**-8.23%**	**-76.10%**	**-15.01%**

***only 40 plants planted and harvested.**

Table 5.5 Accumulated chilling hours (temperatures between 0-7°C) collected at the originating nursery locations in 1999.

Origin	July	August	September	October	Total Chilling Hours
Ile a la Crosse, Canada	0	1	194	Dug	195
Outlook, Canada	0	2	193	Dug	195
La Ronge, Canada.	0	22	195	Dug	217
McArthur, CA for Fall River Nursery USA	46	41	120	44	251

5.3.2.3 Ito Farms

When the Ile a la Crosse plants are compared to the Lassen Canyon crowns, the La Ronge crowns are consistently producing higher yields than Lassen Canyon crowns in the first 2 months of production (Table 5.6). However, Lassen Canyon fruit yield catches up by March and surpasses Ile a la Crosse crowns in this month resulting in an overall yield reduction of 6.5%. Although Ile a la Crosse had fewer total chilling hours (Table 5.7), the yields were still earlier than Lassen Canyon. The earliness response appears to more complicated than strictly total chilling hours received and may be dependent upon the timing of the chilling hours received with respect to the stage of floral development.

La Ronge crowns (with similar chilling hours received as Ile a la Crosse, Table 5.7) were consistently below California-sourced crowns in each month of sampling resulting in an overall yield decrease of 14% (Table 5.6). This result using La Ronge-sourced crowns (Ito Farms in Orange County) is comparable to Mandalay Berry Farms (Oxnard County) for the 2000 production year. However, Mandalay Berry Farms expressed –10% reduction of fruit yield in the first 2 months while Nakama Ranch (Oxnard County) located 2 miles away expressed only –0.5% reduction of yield in the first 2 months of picking (Table 2.1).

Table 5.6 Ito Farms (Orange County, CA) monthly farm yield in kg/ha (pounds/acre) comparison of Outlook, La Ronge and Ile a la Crosse compared to Lassen Canyon Nursery crowns, 2000.

Origin	Jan.	Feb.	Mar.	To April 11	Overall Average
Ile a la Crosse, Canada	4,368 (3,889)	6,801 (6,056)	8,486 (7,556)	6,864 (6,111)	26,519 (23,611)
Lassen Canyon, USA	4,262 (3794)	5,983 (5327)	9,384 (83[illegible])	8,712 (7,757)	28,342 (25,234)
% ± of Cal plants	+2.4%	+13.6%	-9.6%	-11.3%	-6.5%
La Ronge, Canada.	3,215 (2,862)	5,926 (5,276)	8,598 (7,655)	7,126 (6,345)	24,865 (22,138)
% ± of Cal plants	-24.6%	-.01%	-8.4%	-28.3%	-14.0 %

Table 5.7 Accumulated chilling hours (temperatures between 0-7°C) collected at the originating nursery locations in 1999. Canadian locations accumulated chilling hours in August and September while USA location collected hours in July and October due to changes in temperatures and timing of crown harvest.

Origin	July	August	September	October	Total Chilling Hours
Tulelake, CA for Norcal and Lassen Canyon		59	169		228
Ile a la Crosse, Canada	0	1	194	Dug	195
Outlook, Canada	0	2	193	Dug	195
La Ronge, Canada.	0	22	195	Dug	217

Chilling hours for strawberries represent the total number of hours that crowns are exposed to temperatures between 0°C and 7°C. While this range is generally considered active, the reader should be aware that temperatures outside of this range are likely also effective but not to the same extent. Therefore, this range is useful for standardization of chilling hour quantitation and may not reflect the actual total range of effective temperatures. Also, the timing of chilling hours received relative to the stage of floral bud development has been shown by other researchers to be important with respect to efficacy. Ile a la Crosse received greater number of chilling hours in September compared to the Lassen Canyon-sourced crowns. The floral buds were likely more advanced in this month compared to August. The optimum number of chilling hours for strawberries is cultivar-dependent, and the exact optimum number for 'Camarosa' is not known. There is a range from zero chilling requirement to over 1500 hours of chilling. However, the average June-bearing strawberry crown requires at least 200 chilling hours to the floral buds for proper growth to occur, otherwise the plant will remain vegetative. The duration of exposure to chilling temperatures for 'Camarosa' may be much less than cultivars bred for colder regions in Canada.

A second explanation for reduced yield compared to previous years in the La Ronge-sourced crowns is damage due to temperatures below zero. The day before and morning of harvest, temperatures had dipped to sub-zero temperatures. On the 26th of September, 1999 from 5:00 to 7:00 AM, temperatures were recorded as –4, -6 and -10°C. On the morning of the 28th, between 2:00 and 4:00 AM, temperatures were recorded as –5, -11, and -7°C (Appendix). Nestby and Bjorgum (1999) found that strawberry crowns from cultivars 'Bounty', 'Senga Sengana' and 'Korona' had reduced yields of 41 to 66% when held at -8°C for 2 hours. These temperatures may have injured the 'Camarosa' crowns causing a decrease in sequential yields in the 2000 fruiting year for La Ronge-sourced crowns. However, it is unknown why there would be such a difference in response for La Ronge-sourced plants at Mandalay and Nakama Ranch. Sampling procedure and sampling size may have been a factor. Mandalay Farms used 40 plants while Nakama Ranch sampled on a 1000 plant basis in the 2000 fruit production year.

5.3.3 2000 Crown Production, 2001 Fruit Production year

Figure 5.12 'Camarosa' strawberry plot in Manning, AB. Plants being dug in the end of September (left) and plot earlier in the spring (right).

Figure 5. 13 'Camarosa' strawberry plants at Good Soil, (near Meadowlake) SK. courtesy of Brenda Lange.

Table 5. 8 Accumulated chilling hours (temperatures between 0-7°C) collected at the originating nursery locations in 2000.

Origin	July	August	September	October	Total Chilling Hours
Meadow Lake , Canada	0	77	219	Dug	296
Outlook, Canada	0	0	111	Dug	111
La Ronge, Canada.	0	93	335	Dug	428
Fairview and Manning, AB Canada	0	50	214	Dug	264
Tulelake, CA		78	176		254

5.3.3.1 Ito Farms

These results represent total monthly yield (kg) comparisons for 150 strawberry plants from Manning, Fairview Fort Vermillion (three locations in Alberta) and Outlook, Saskatchewan (Table 5.9). Seventy strawberry plants from Meadow Lake were planted. All Canadian sites were compared to 150 plants from Lassen Canyon Nursery in Redding, CA all planted on October 18th 2000 and normalized on a per plant basis.

Alberta sites did not perform well compared to California-sourced crowns in any of the sampling months. This was the first year of production for Alberta and factors of cultural practice and harvesting process could have negatively impacted subsequent fruiting yields. In some cases, crowns were trimmed too close to the growing points.

By contrast, the Meadowlake, SK site outperformed California-sourced crowns by +21.4% in the first 2 months of fruit production. As previously observed at other locations, California-sourced crowns caught up in March resulting in an overall reduction of yield by –2.9%.

Table 5. 9 Ito Farms (Orange County, CA) fruit yield kg/ha (pounds/acre) in 2001 of Canadian-grown strawberry crowns compared to California-sourced crowns as a % +/-.

Origin	January	February	March	To April 11	Overall Yield
Manning, AB	991 (882)	3,964 (3,529)	6,111 (5,441)	10,901 (9,706)	21,968 (19,559)
Lassen Canyon, CA	2808 (2500)	4790 (4265)	9580 (8529)	16,517 (14,706)	33,695 (30,000)
% ± of Cal plants	**-64.71%**	**-17.24%**	**-36.36%**	**-34.00%**	**-34.83%**
Fairview, AB	1156 (1029)	6111 (5441)	9250 (8235)	13,874 (12,353)	30,391 (27,059)
Lassen Canyon,CA	2808 (2500)	4790 (4265)	9580 (8529)	16,517 (14,706)	33,695 (30,000)
% ± of Cal plants	**-58.82%**	**+27.59%**	**-3.64%**	**-16.00%**	**-9.95%**
Fort Vermillion, AB	1734 (1544)	4460 (3971)	7185 (6397)	12,223 (10,882)	25,601 (22,794)
Lassen Canyon,CA	2808 (2500)	4790 (4265)	9580 (8529)	16,517 (14,706)	33,695 (30,000)
% ± of Cal plants	**-38.24%**	**-6.90%**	**-23.64%**	**-26.00%**	**-23.63%**
Meadow Lake, SK.	2407 (2143)	6819 (6071)	9627 (8571)	16,045 (14,286)	34,898 (31,071)
Lassen Canyon,CA	2808 (2500)	4790 (4265)	9580 (8529)	16,517 (14,706)	33,695 (30,000)
% ± of California plants	**-14.28%**	**+42.35%**	**+0.4%**	**-2.9%**	**+3.5%**

5.3.3.2 Nakama Ranch 2001 fruit production year

In the 2001 fruit production year at Nakama Ranch, La Ronge-sourced crowns reduced both early yield and total end of season yield below that of California-sourced crowns (Table 2.1). It is unclear if total chilling requirement is a factor. In the 2000 crown production year, the summation of the August and September chilling requirement is comparable at Tulelake, Fairview, Manning and Meadowlake locations (Table 5.8) and yet fruit yield response is widely different (Table 5.9). Furthermore, the La Ronge site accumulated the highest number of chilling hours and yet still resulted in depressed yield. Yield itself may not be related to chilling requirement fullfillment. However, rate of flowering, may be directly related to chilling requirement (Section 9) and timing of the chilling received.

5.3.4 2001 Crown Production, 2002 Fruit Production year

In contrast to the previous year, most Alberta locations produced greater yields in the first month compared to California-sourced crowns. Manning, Fairview and Fort Vermillion had +26.2%, + 41.1% and + 7.6% greater yields in January compared to Lassen Canyon-sourced crowns (Table 5.10). However, yields subsequently decreased from February resulting in total overall marketable yield over 20% below that of Lasson Canyon-sourced crowns by April 11.

The Meadowlake, SK site continued to express high yields in the first 2 months and the La Ronge site also showed greater yields in January and February (Table 5.10). Meadowlake and La Ronge produced + 32.8% and + 11.6% higher yields in the first two months above California-sourced crowns (Table 2.1). Yields again subsequently declined in March and were lower than California-sourced crowns by the end of the fresh pick season.

Table 5. 10 Ito Farms (Orange County, CA) fruit yield kg/ha (pounds/acre) in 2002 of Canadian-grown strawberry crowns compared to California-sourced crowns as a % +/-.

Origin	January	February	March	To April 11	Overall Yield
Manning, AB	4,440 (3,953)	3,526 (3,140)	9,273 (8,256)	10,187 (9,070)	27,426 (24,419)
% ± of Cal plants	**+26.2%**	**-8.6%**	**-51.3%**	**+11.6%**	**-22.9%**
Fairview, AB	4,963 (4,419)	3,526 (3,140)	9,534 (8,488)	8,097 (7,209)	26,120 (23,256)
% ± of Cal plants	**+41.1%**	**-8.6%**	**-50.0%**	**-11.3%**	**-26.5%**
Fort Vermillion, AB	3,787 (3,372)	3,526 (3,140)	10,709 (9,535)	9,926 (8,837)	27,948 (24,884)
% ± of Cal plants	**+7.6%**	**-8.6%**	**-43.7%**	**+8.8%**	**-21.4%**
Carajou, AB	3,396 (3,023)	3,918 (3,488)	9,795 (8,721)	10,709 (9,535)	27,818 (24,767)
% ± of Cal plants	**-3.5%**	**+1.6%**	**-48.5%**	**+17.4%**	**-21.4%**
Meadow Lake, SK.	6008 (5349)	3787 (3372)	13,060 (11,628)	9664 (8605)	32,520 (28,953)
% ± of California plants	**+70.8%**	**-1.8%**	**-31.4%**	**+5.9%**	**-8.5%**
La Ronge, SK	3,787 (3,372)	4,440 (3,953)	7,314 (6,512)	7,052 (6,279)	22,594 (20,116)
% ± of California plants	**+7.7%**	**+15.2%**	**-61.6%**	**-22.8%**	**-36.4%**
Lassen Canyon,CA	**3,518 (3,132)**	**3,855 (3,432)**	**19,031 (16,944)**	**9,124 (8,124)**	**35,528 (31,632)**

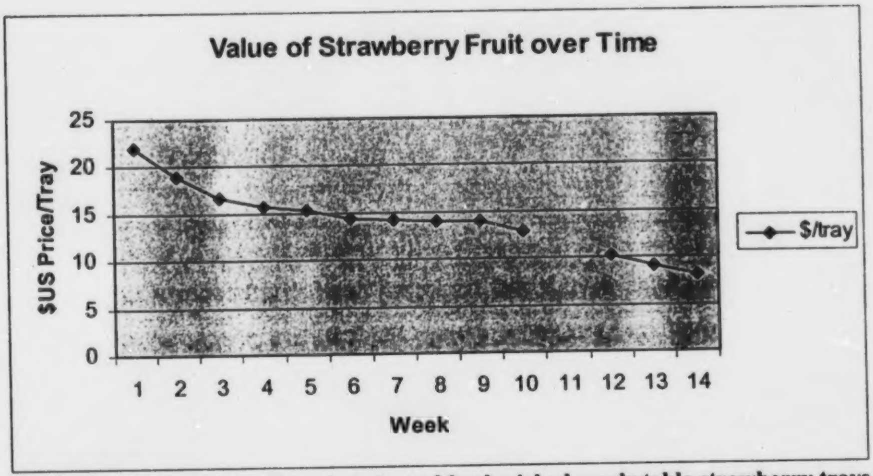


Figure 5. 14 California wholesale prices of fresh picked marketable strawberry trays over time.Week 1 = January 12, 2002

Table 5. 11 Summary of marketable strawberry fruit yield over a 7 year period from 1996-2002 and comparison between California-sourced and northern Saskatchewan and Alberta-sourced strawberry crowns

Fruit Production Year	California Location of Fruit Production	Source of Crowns	Marketable Yield kg/ha (lbs/acre)			
			Jan. + Feb.	+/- %	Total	+/- %
1996	Irvine, California (South Coast Research Station)	Norcal, CA	11,480 (10,221)		115,369* (102,718)	
		La Ronge, SK	16,766 (14,927)	+69%	124,974 (111,269)	+11%
1997	Irvine, California (South Coast Research Station)	Norcal, CA	6,422 (5,718)		97,297* (86,627)	
		La Ronge, SK	9,036 (8,045)	+40%	110,937 (98,771)	+14%
1999	Nakama Ranch, Oxnard, CA.	Lassen Canyon, CA	4,724 (4,208)		45,360** (40,409)	
		La Ronge, SK	5,788 (5,157)	+23%	53,386 (47,559)	+18%
2000	Nakama Ranch, Oxnard, CA.	Fall River, CA	8,245 (7,341)		15,724*** (14,000)	
		Ile a la Crosse, SK	7,086 (6,310)	-16%	11,618 (10,344)	-35.3%
		La Ronge, SK	8,207 (7,307)	-0.5%	13,918 (12,392)	-13.0%
	Mandalay Farms, Oxnard, CA	Fall River, CA	6,993 (6,226)		60,995* (54,306)	
		La Ronge, SK	6,348 (5,652)	-10%	51,831 (46,147)	-18%
	B&E Farms, Orange County, CA	Lassen Canyon, SK	10,245 (9,121)		28,342*** (25,234)	
		Ile a la Crosse, SK	11,169 (9,945)	+9%	26,519 (23,611)	-6.9%
		La Ronge, SK	9,141 (8,138)	-12%	24,865 (22,138)	-14.0%
2001	Nakama Ranch, Oxnard, CA.	Norcal, CA	6,473 (5,763)		13,631**** (12,136)	
		La Ronge, SK	5,769 (5,136)	-12.2%	10,442 (9,297)	-23.4%
	B&E Farms, Orange County, CA	Lassen Canyon, CA	7,598 (6,765)		16,517*** (14,706)	
		Meadowlake, SK	9,226 (8,214)	+21.4%	16,045 (14,286)	-2.9%
		Manning, AB	4,955 (4,411)	-53.3%	10,901 (9,706)	-34.0%
		Fairview, AB	7,267 (6,470)	-4.6%	13,874 (12,353)	-16.0%
		Fort Vermillion, AB	6,194 (5,514)	-22.7%	12,223 (10,882)	-26.0%

2002	B&E Farms, Orange County, CA	Lassen Canyon, CA	7,373 (6,564)		9,124*** (8,124)	
		Meadowlake, SK	9,795 (8,721)	+32.8%	9,664 (8,605)	+5.9%
		Manning, AB	7,966 (7,093)	+8.0%	10,187 (9,070)	+11.6%
		Fairview, AB	8,489 (7,559)	+15.1%	8,097 (7,209)	-11.3%
		Fort Vermillion, AB	7,313 (6,512)	-0.8%	9,926 (8,837)	+8.8%
		Carajou, AB	7,314 (6,511)	-0.8%	10,709 (9,535)	+17.4%

+/- represents the percentage above or below California-sourced crowns.

***Fruit yield to June 30; **Fruit yield to May 30; ***Fruit yield to April 11; ****Fruit yield to March 31.**

5.3.5 Berry Size of Northern Saskatchewan-sourced crowns.

2000 fruit production year:

Mandalay Farms: Both Canadian locations of La Ronge and Outlook, SK-sourced crowns produced marketable fruit which were larger in February and March (Table 5.12). In the first two months of sampling, the Outlook and La Ronge locations produced fruit sizes that were + 20.5% and + 16.0% greater than Fall River-sourced crowns, respectively (Table 2.2).

Significant differences were seen between the date of harvest. Samples collected in February and March were significantly ($p \leq 0.01$) larger than fruit samples in April. Significant differences were also noted within the date*source interaction. La Ronge fruit samples in February were greater ($p \leq 0.01$) than the California-sourced material. No differences were noted between the February and March plant material from either location. However, in comparing these two months to April, a significant ($p \leq 0.01$) decrease in fruit weight was noted. Trend analysis indicates that a significant ($p \leq 0.01$) linear trend exists between the dates of harvest for all locations tested (California, La Ronge and Outlook). The first fruit harvested had a higher average weight than fruit collected at later dates. The decline in yield over time can be explained in terms of strawberry fruiting sequence. The "king" berry, the first fruit produced on the plant, is normally the largest and each successive fruit is gradually smaller, thus the gradual decrease in fruit weight is expected.

Table 5.11 Comparison of berry weight during the harvesting period of January to April, 2000 at Mandalay Berry Farm. Table

Source	Date of Harvest	Mean Weight of Ten Fruit (g)
Fall River Nursery, USA	8-Feb-00	337.0
La Ronge, Canada	8-Feb-00	391.0
Outlook, Canada	8-Feb-00	406.3
Fall River Nursery, USA	7-Mar-00	372.3
La Ronge, Canada	7-Mar-00	360.7
Outlook, Canada	7-Mar-00	393.0
Fall River Nursery, USA	4-Apr-00	260.0
La Ronge, Canada	4-Apr-00	261.3
Outlook, Canada	4-Apr-00	246.0
Statistical Significance		
Source		*
LSD		19.4
Date		**
LSD		25.1
*Date*Source*		**
LSD		45.3

† * denotes significance at $p<0.05$, ** denotes significance of $p<0.01$.

Table 5. 12 Comparison of berry weights (g) at Nakama Ranch during the harvest period of January to April, 2000.

Source	Date of Harvest	Mean Weight of Ten Fruit (g)
Fall River Nursery, USA	20-Jan-00	413.3
Outlook, Canada	20-Jan-00	418.0
Ile a la Crosse, Canada	20-Jan-00	366.1
La Ronge, Canada	20-Jan-00	408.6
Fall River Nursery, USA	19-Feb-00	363.7
Outlook, Canada	19-Feb-00	401.5
Ile a la Crosse, Canada	19-Feb-00	350.8
La Ronge, Canada	19-Feb-00	477.3
Fall River Nursery, USA	20-Mar-00	359.0
Outlook, Canada	20-Mar-00	401.5
Ile a la Crosse, Canada	20-Mar-00	343.7
La Ronge, Canada	20-Mar-00	342.4
Fall River Nursery, USA	1-Apr-00	340.1
Outlook, Canada	1-Apr-00	392.0
Ile a la Crosse, Canada	1 -Apr-00	326.0
La Ronge, Canada	1 -Apr-00	337.7
Statistical Significance		
Source		ns
Date		ns
Date*Source		ns

†-samples consist of ten berries each. ,-ns denotes no significant differences.

Nakama Ranch 2000 production year: While fruit size was not significantly different (Table 5.13), mean sizes of the early fruit harvested in January and February was +5.4% and + 13.9% for Outlook and La Ronge-sourced crowns, respectively (Table 2.2) compared to California-sourced material. By the end of the season, Outlook-sourced material also expressed +15.3% greater fruit size while La Ronge-sourced crowns were roughly equivalent to Fall River, CA-sourced crowns.

For La Ronge, Ile a la Crosse and Fall River crown sources, trend analysis indicated a significant ($p<0.1$) linear trend with berry weights starting high and decreasing (Data not shown). Outlook had no significant trend present and maintained berry size throughout the sampling period.

Table 5. 13 Comparison of berry weight at Ito Farms during the harvest period of January to March 2000.

Source	Date of Harvest	Mean Weight of Ten Fruit (g)
Lassen Canyon Nursery, USA	20-Jan-00	293.0
La Ronge, Canada	20-Jan-00	323.7
Outlook, Canada	20-Jan-00	349.7
Ile a la Crosse, Canada	20-Jan-00	311.9
Lassen Canyon Nursery, USA	2-Feb-00	333.1
La Ronge, Canada	2-Feb-00	349.7
Outlook, Canada	4-Feb-00	349.7
Ile a la Crosse, Canada	4-Feb-00	361.5
Lassen Canyon Nursery, USA	29-Feb-00	387.2
La Ronge, Canada	29-Feb-00	311.9
Outlook, Canada	29-Feb-00	333.1
Ile a la Crosse, Canada	29-Feb-00	308.3
Lassen Canyon Nursery, USA	16-Mar-00	297.7
La Ronge, Canada	16 -Mar-00	304.8
Outlook, Canada	16-Mar-00	340.2
Ile a la Crosse, Canada	16-Mar-00	316.6
Statistical Significance		
Source		*
LSD		26.71
Date		**
LSD		36.84
Date*Source		**
LSD		69.60

†-samples consist of ten berries each, ns = not significant; * and** are $p \leq 0.05$ and $p \leq 0.01$.

Ito Farm berry size, 2000 production year: All Saskatchewan-sourced crowns produced fruit significantly larger in both the first 2 months as well as at the end of the season (Tables 5.14, 2.2). Saskatchewan-sourced crowns elevated yields by on average 9% in the first 2 months and by 8% overall.

As observed at the Nakama Ranch location, Outlook plants produced uniform fruit at Ito Farms in 2000. The average weight only varied from 33.31 to 34.97g. throughout the season. By contrast, the Lassen Canyon fruit fluctuated from 29.30g to 33.55g, back down to 29.77g. Ile a la Crosse's fruit weights also varied. Average berry weights begin at 32.37g go up to 36.15g and then decrease to 20.55g with a recovery to 31.66g. Trend analysis was conducted on all sites. La Ronge and Outlook had no significant trends. Lassen Canyon Nursery crowns had a significant ($p \leq 0.01$) quadratic trend indicating that fruit weights increased to a point and then decreased. Ile a la Crosse had a significant ($p \leq 0.05$) cubic trend indicating that fruit weight decreased, increased and then decreased again.

2001 fruit production year: fruit size

Nakama Ranch: Berry samples consisting of ten berries each were taken at various harvest dates throughout the season. No significant differences were noted for source or date of harvest*source interaction. Date was again significant indicating a change in size between sampling dates. However, unlike previous years, the size of fruit appears to be getting larger with time (Table 5.15).

Table 5. 14 Comparison of berry weight during the harvesting period of January to March, 2001 at Nakama Ranch.

Source	Date of Harvest	Mean Weight of Ten Fruit (g)
Lassen Canyon, USA	23-Jan-01	251.5
Outlook, Canada	23-Jan-01	224.4
Lassen Canyon, USA	31-Jan-01	538.5
Outlook, Canada	31-Jan-01	425.1
Lassen Canyon, USA	5-Feb-01	604.6
Outlook, Canada	5-Feb-01	519.6
Lassen Canyon, USA	21-Feb-01	547.9
Outlook, Canada	21-Feb-01	595.1
Lassen Canyon, USA	8-Mar-01	255.1
Outlook, Canada	8-Mar-01	240.9
Lassen Canyon, USA	23-Mar-01	392.0
Outlook, Canada	23-Mar-01	415.7
Statistical Significance		
Source		ns
Date		**
LSD		237.72
*Date*Source*		ns

† ** denotes significance of $p<0.01$, ns = not significant

Table 5. 15 Summary of marketable fruit size and comparison between California-sourced and Northern Saskatchewan-sourced strawberry crowns

Fruit Production Year	California Location of Fruit Production	Source of Crowns	Mean Fruit weight (g/fruit)			
			Jan. + Feb.	+/- %	End of season	+/- %
1996	Irvine, California (South Coast Research Station)	Norcal, CA	36.3		28.5	
		La Ronge, SK	37.6	+3.6%	29.2	+2.5%
1997	Irvine, California (South Coast Research Station)	Norcal, CA	34		28	
		La Ronge, SK	35	+3%	29	+3.5%
1999	Nakama Ranch, Oxnard, CA.	Lassen Canyon, CA				
		La Ronge, SK				
2000	Nakama Ranch, Oxnard, CA.	Fall River, CA	38.9		34.0	
		Ile a la Crosse, SK	35.9	-8.4%	32.6	-4.3%
		La Ronge, SK	44.3	+13.9%	33.8	-0.6%
	Mandalay Farms, Oxnard, CA	Fall River, CA	33.7		26.0	
		La Ronge, SK	39.1	+16.0%	26.1	+0.4%
	B&E Farms, Orange County, CA	Lassen Canyon, SK	31.3		29.7	
		Ile a la Crosse, SK	33.7	+7.7%	31.7	+6.7%
		La Ronge, SK	33.7	+7.7%	30.5	+2.7%
2001	Nakama Ranch, Oxnard, CA.	Norcal, CA	48.6		39.2	
		La Ronge, SK	44.1	-10.2%	41.6	+6.1%

+/- represents the percentage above or below California-sourced crowns.

5.4 Conclusions

In terms of early yield, over a 7 year period, Canadian-sourced crowns out-performed California-sourced crowns in each year from at least one Canadian-sourced location (Table 5.11). Since the highest prices of marketable fruit occur in these first 2 months (Table 5.13), early yield will be of advantage to California producers. However, this early yield response was variable. In the first 3 years of observation, Canadian-sourced crowns consistently expressed higher yields in the first two months of marketable fruit production. In the following 2 years, results were more variable depending upon Canadian source and U.S. location of fruit production. In the most recent results (2002 fruit production year), yields from Canadian-sourced crowns were again consistently higher than California-sourced crowns. Overall total yields at the end of the season were not consistently higher than California-sourced crowns and in the majority of cases, was lower than the U.S.-sourced crowns. Since the northern vigour phenomenon is environmentally-regulated, it is important to continue to profile yield response over a number of years.

In terms of fruit size over a 5 year period, mean fruit size of Saskatchewan-sourced crowns were generally larger than California-sourced crowns both in the first 2 months and by the end of the season. High variation in results prevented detection of significant differences in some locations. Trend analysis showed an expected reduction in fruit size from the early to late fruiting season.

6.0: Evaluation of 'Northern Vigour®' Potential in Southern Regions of Saskatchewan

6.1 Objective

The objective of this study is to determine if 'Northern Vigour®' is expressed in strawberry crowns grown in southern regions of the province. Southern regions of the province, such as, Outlook, Saskatchewan (51°.30' Latitude), have the potential to develop into strawberry producing areas.

In Outlook and surrounding area advantages such as irrigation facilities, loamy soils and the presence of knowledgeable growers create an ideal growing area for strawberries. The potato industry in this area is expanding quickly and many of the farmers are looking for new crops to be used within crop rotations. Strawberry crown production is one type of crop which could be considered providing a market is established.

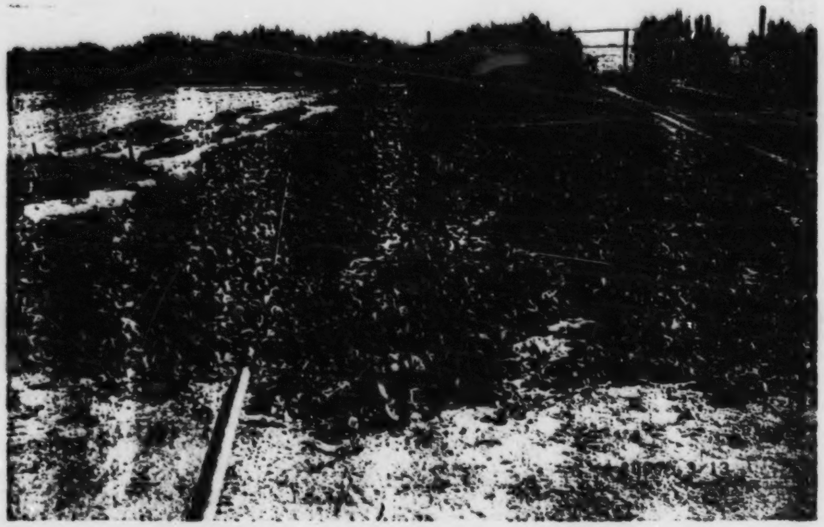


Figure 6.1 'Camarosa' plot on the 13th of September 2000 at Bill King's in Outlook, SK.

6.2 Materials and Methods

6.2.1 1998 Crown Production season

The site was located at Outlook, Saskatchewan on the property of Bill and Jean King's were they own and operate a market garden. One hundred 'Camarosa' strawberry crowns were planted on May 28th, 1998. Fertilizing was done by the cooperator prior to planting. Plants were irrigated regularly utilizing drip tubing. Blossoms were removed at random intervals to facilitate runnering of the plant material. Plants were harvested on September 22, 1998 and taken to Saskatoon were trimming and packaging took place. Each mother crown produced approximately 4 daughter crowns. Many daughter plants were produced, however, only a small number had proper root systems for re-planting. The crowns were shipped out on October 5th, 1998 to Nakama Ranch, c/o Mr. Chas Nakama for further observations. Observations include date of establishment, date of flowering and fruit yields will be collected monthly.

As a comparison, one hundred crowns were planted at two other smaller sites in the northern regions of the province, Ile a'-la Crosse (55°.23' Latitude) courtesy of Mr. Rodney Gardiner and Meadow Lake, Saskatchewan (54°.06' Latitude) courtesy of Mr. Dave Cubbon. Planting occurred during the first week of May and was maintained following the cultural practices for the region. Harvesting occurred during the third week in September and were shipped to Saskatoon, Saskatchewan for trimming. Meadow Lake samples were not sent due to the low number of daughters produced.

The trial consisted of 4 locations, Outlook, Ile a'-la Crosse, LaRonge and California plant material. Each location consisted of 4 replications with 50 plants per replication. Crowns were planted in the greenhouse and observed for date of flowering and yield.

The trial consisted of 4 locations, Outlook, Ile a-la Crosse, La Ronge and California. Each location contained 4 replications with 50 plants per replication. Data regarding date of establishment, date of flowering and monthly fruit yields were collected at monthly intervals. Ten crowns from Outlook, Ile a-la Crosse and Meadow lake were planted in 4" x 4" pots filled with No. 4 'Sunshine' growing medium and were grown at 16h daylengths at 22° ± 2°C day and 16 ± 2°C night temperatures in the Agriculture greenhouses in Saskatoon. Data was collected regarding date of establishment, date of flowering and date of runnering three times a week. Fruit yields were collected weekly.

6.2.2 1999 Crown Production Season

Six hundred 'Camarosa' strawberry crowns were planted in Outlook, Saskatchewan on the 3rd of June 1999. Fertilizer was applied prior to planting according to soil analysis performed by Enviro-Test Laboratories – Plains Innovative Laboratory Services. Crowns were planted 30cm apart within rows with a 1.5m spacing between rows to allow for mechanical plot maintenance. The research plot was maintained following the recommended cultural practices for the region with irrigation occurring throughout the season as was deemed necessary (Figure 1.5). Harvesting occurred during September 30th. Crowns were dug using a small potato harvester, trimmed and placed into plastic bags for transport to Saskatoon. On average Outlook produced 7 daughters per mother crown respectively. Many daughter plants were produced, however, only a small number had proper root systems for re-planting. On October 6th a thousand crowns were shipped to each cooperator via courier to Nakama Ranch, c/o Mr. Chas Nakama in Oxnard, California, B & E Farms, c/o Mr. Bill Ito in Westminster, CA and to Dallum Farms, c/o Mr. John Dallum also of the Oxnard, CA area.

6.2.3 2000 Crown Production Season

Six hundred 'Camarosa' strawberry crowns were planted in Outlook, Saskatchewan on the 10th of May 2000. Fertilizer was applied prior to planting according to soil analysis recommendations provided by Enviro-Test Laboratories – Plains Innovative Laboratory Services. Crowns were planted 30cm apart within rows with a 1.5m spacing between rows to allow for mechanical plot maintenance. The research plot was maintained following the recommended cultural practices for the region with irrigation occurring throughout the season as necessary (Figure 1.10). Harvesting occurred on October 2nd. Digging in Outlook was delayed due to concerns with the low number of accumulated chilling hours. Chilling hours for strawberries are temperatures that are between 0°C and 7°C. The optimum number of chilling hours for strawberries is cultivar dependent, and the optimum number for 'Camarosa' is not known, however, it is a general practice for 200-400 to be accumulated before harvest. Tables 1.23 and 1.24 list the temperatures recorded every hour for the months of August and September when chilling hours are critical. August provided no chilling hours, while September saw only 111 chilling hours. Although more chilling hours are believed to be desirable, the time frame in which California growers require plant material is usually during the end of September and already the time frame for marketability to California was decreasing. Crowns were dug using a small potato harvester and placed into plastic bags for transport to Saskatoon for trimming. On average Outlook produced 11 daughters per mother crown. On October 16th a thousand crowns were shipped to each cooperator via courier to Nakama Ranch, c/o Mr. Chas Nakama in Oxnard, California and B & E Farms, c/o Mr. Bill Ito in Westminster, CA. Marketable fruit yield data were collected and compared to California-sourced plant material.

6.2.4 2001 Production Season

Two hundred and fifty crowns were planted in Outlook on May 29 at the Saskatchewan Irrigation Diversification Centre. One hundred crowns were shipped on October 2 via courier to B&E Farms, Orange county, CA (Bill Ito and Steve Ozawa).

6.2.5 2002 Production Season

Since the northern vigour phenomenon is environmentally regulated, it is important to continue to obtain long-term data on California fruit yield response to Saskatchewan-grown crowns. Therefore, two hundred and fifty crowns were again planted at Bill & Jean King's Market Garden in Outlook, Saskatchewan. The 2002 spring season was unseasonably cool and occurred on May 26. Since the final report is due before the results of the California 2003 fruit yield data will be available, those fruit yield results will be combined with the ADF grant # 20010051.

6.2.6 Fruit Size

Fruit size was determined by the various growers in the California locations. Three to four groups of 10 fruit per group (fruit was randomly picked) were picked and weighed at monthly intervals.

6.2.7 Greenhouse studies

The trial consisted of 4 locations, Outlook, Ile a-la Crosse, La Ronge and California. Each location contained 4 replications with 50 plants per replication. Data regarding date of establishment, date of flowering and monthly fruit yields were collected at monthly intervals. Ten crowns from Outlook, Ile a-la Crosse and Meadow lake were planted in 4" x 4" pots filled with No. 4 'Sunshine' growing medium and are growing at 16h daylengths at 22° ± 2°C day and 16 ± 2°C night temperatures in the Agriculture greenhouses in Saskatoon. Data was collected regarding date of establishment, date of flowering and date of runnering three times a week. Fruit yields were collected weekly.

6.3 Results

6.3.1 Fruit yield

Early fruit yield advancement based on the Outlook-sourced crowns was variable (Table 6.8). This variation in response was dependent upon both the California grower (Tables 6.1, 6.2, 6.3) as well as the year of crown production when compared at the same grower site (Tables 6.3, 6.4, 6.6).

Overall, it is not certain why the Outlook sourced crowns only yielded well at Mandalay Berry Farms. Possible variations could exist in the number of plants, which were initially planted at each test site in California. Mandalay Farms plant 40 plants from each source while Nakama Ranch and Ito Farms planted a larger number of crowns for harvesting.

The Outlook-sourced crowns expressed an increased yield compared to California-sourced crowns in either January or February of every year. However, this increase was temporary and resulted in a net decrease in overall yields.

The variation in the number of chilling hours received by all of the Saskatchewan plant material may also have a direct effect on the yield of the crowns.

Table 6.1 Nakama Ranch (Oxnard, CA) comparison of 'Camarosa' yields kg/ha (pounds/acre) originating from Outlook, SK. compared to California 'Camarosa' from Fall River (McArthur, CA) in 2000

Origin	January	February	March	April	Overall Yield
Outlook, Canada	3,961 (3,527)	3,896 (3,469)	3,738 (3,328)	1,245 (1,109)	13,746 (12,239)
Fall River, CA	5,384 (4,793)	3,653 (3,253)	5,664 (5,043)	2,718 (2,420)	17,419 (15,509)
% ± of Cal plants	-26.41%	+6.63	-34.00	-54.16%	-21.08

Table 6.2 Mandalay Berry Farms yield kg/ha (pounds/acre) comparisons of Outlook, SK-grown strawberry crowns to 'Camarosa' crowns grown at Fall River Nursery in McArthur, CA from December 1999 to June 2000 Table 6.2.

Origin	Dec.	Jan.	Feb.	Mar.	April	May	June	Overall Yield
Outlook, Canada	45 (40)	3,833 (3,413)	5,099 (4,540)	7,638 (6,801)	10,673 (9,503)	25,307 (22,532)	7,823 (6,965)	60,427 (53,800)
Fall River, CA	97 (86)	3,383 (3,012)	3,610 (3,214)	7,412 (6,600)	10,156 (9,042)	27,740 (24,698)	8,596 (7,653)	60,995 (54,306)
% ± of Cal plants	-52.94%	+13.31%	+41.24%	+3.04%	+5.09%	-8.76%	-8.99%	-0.94%

*only 40 plants planted and harvested.

Table 6.3 Ito Farms (Orange County, CA) monthly farm yield in kg/ha (pounds/acre) comparison of Outlook, La Ronge and Ile a la Crosse compared to Lassen Canyon Nursery crowns, 2000.

Origin	Jan.	Feb.	Mar.	To April 11	Overall Average
Outlook, Canada	4,738 (4,219)	5,230 (4,656)	8,985 (8,000)	6,072 (5,406)	25,026 (22,281)
Lassen Canyon, USA	4,262 (3794)	5,983 (5,327)	9,384 (8,355)	8,712 (7,757)	28,342 (25,234)
% ± of Cal plants	**+11%**	**-13%**	**-5%**	**-31%**	**-12%**

Table 6. 4 Ito Farms (Orange County, CA) fruit yield kg/ha (pounds/acre) in 2001 of Outlook, SK-grown strawberry crowns compared to California-sourced crowns as a % +/-.

Origin	January	February	March	To April 11	Overall Yield
Outlook, SK	1487 (1323)	4707 (4191)	6524 (5809)	12,883 (11,471)	25,601 (22,794)
Lassen Canyon,CA	2808 (2500)	4790 (4265)	9580 (8529)	16,517 (14,706)	33,695 (30,000)
% ± of Cal plants	**-47.06%**	**-1.72%**	**-30.91%**	**-22.00%**	**-23.63%**

Table 6. 5 Nakama Ranch, Oxnard, CA yield kg/ha (pounds/acre) in 2001 comparison of Canadian strawberry crowns compared to California as a % +/- .

Origin	January	February	March	Overall Yield
Outlook, Canada	1012 (901)	4757 (4235)	4673 (4161)	10,442 (9,297)
Norcal Nursery, USA	1921 (1710)	4552 (4053)	7157 (6372)	13,631 (12,136)
% ± of California plants	**-47.32%**	**+4.48%**	**-34.71%**	**-23.39%**

Table 6. 6 Ito Farms (Orange County, CA) fruit yield kg/ha (pounds/acre) in 2002 of Outlook-grown strawberry crowns compared to California-sourced crowns as a % +/-.

Origin	January	February	March	To April 11	Overall Yield
Lassen Canyon,CA	3,518 (3,132)	3,855 (3,432)	19,031 (16,944)	9,124 (8,124)	35,528 (31,632)
Outlook, SK	4,832 (4,302)	3,787 (3,372)	11,493 (10,233)	8,358 (7,442)	28,471 (25,349)
% ± of Cal plants	**+37.4%**	**-1.8%**	**-39.6%**	**-8.4%**	**-19.9%**

6.7 Accumulated chilling hours (temperatures between 0-7°C) collected at the originating nursery locations.

Crown Production Year	Origin	July/August	September	October to the time of harvest	Total Chilling Hours
1999	*McArthur, CA*	87	120	44	251
	Tulelake, CA	59	169		228
	Outlook SK	2	193		195
2000	*Tulelake, CA*	42	157		199
	Outlook SK	0	111		111
2001	*Tulelake, CA*	42	157		199
	Outlook, SK				

Table 6. 8 Summary of marketable strawberry fruit yield in southern locations and comparison between California-sourced and Southern Saskatchewan-sourced strawberry crowns.

Fruit Production Year	California Location of Fruit Production	Source of Crowns	Marketable Yield kg/ha (lbs/acre)			
			Jan. + Feb.	+/- %	Total	+/- %
1997	Irvine, California (South Coast Research Station)	Norcal, CA	6,422 (5,718)		97,297* (86,627)	
		Saskatoon, SK	7,388 (6,578)	+15%	107,697 (95,887)	+11%
2000	Nakama Ranch, Oxnard, CA.	Fall River, CA	8,245 (7,341)		15,724*** (14,000)	
		Outlook, SK	7,857 (6,996)	-5%	13,746 (12,239)	-14.4%
	Mandalay Farms, Oxnard, CA	Fall River, CA	6,993 (6,226)		60,995* (54,306)	
		Outlook, SK	8,932 (7,953)	+22%	60,427 (53,800)	-.01%
	B&E Farms, Orange County, CA	Lassen Canyon, SK	10,245 (9,121)		28,342*** (25,234)	
		Outlook, SK	9,968 (8,875)	-2.8%	25,026 (22,281)	-13.3%
2001	B&E Farms, Orange County, CA	Lassen Canyon, CA	7,598 (6,765)		16,517*** (14,706)	
		Outlook, SK	6,194 (5,514)	-22.7%	12,883 (11,471)	-22.0%
2002	B&E Farms, Orange County, CA	Lassen Canyon, CA	7,373 (6,564)		9,124*** (8,124)	
		Outlook, SK	8,619 (7,674)	+16.9%	8,358 (7,442)	-8.4%

+/- represents the percentage above or below California-sourced crowns.
Fruit yield to June 30; **Fruit yield to May 30; ***Fruit yield to April 11.

6.3.2 Marketable Fruit Size

Berry data was taken at various points throughout the harvest to monitor the change in berry fruit weight and to compare the fruit size of the various sites. Statistical analysis was conduced to determine if significant differences were noted between the source, date of harvest and date of harvest*source interaction. At the Nakama Ranch site, significant differences ($p \leq 0.05$) were noted for the source of plant material and harvest date (Table 6.8). In comparing originating planting source, the Outlook and Californian fruit were significantly larger than Ile a la Crosse fruit. Outlook-sourced fruit were larger than all other locations in 3 out of the 4 months sampled. When comparing the months of harvest, crowns produced significantly ($p \leq 0.05$) larger fruit in January. This is likely due to the formation of the first fruit on the strawberry crowns – otherwise known as the "King Berries". There was no date*source interaction.

Table 6. 7 Nakama Ranch berry size comparison.

Source	**Date of Harvest**	**Mean Weight of Ten Fruit (g)**
California	20-Jan-00	414.6
Outlook	20-Jan-00	421.7
Ile a la Crosse	20-Jan-00	365.0
California	19-Feb-00	379.2
Outlook	19-Feb-00	348.9
Ile a la Crosse	19-Feb-00	350.8
California	20-Mar-00	368.5
Outlook	20-Mar-00	400.4
Ile a la Crosse	20-Mar-00	343.7
California	1-Apr-00	372.1
Outlook	1-Apr-00	41!.1
Ile a la Crosse	1 -Apr-00	326.0
Statistical Significance		
Source		*
LSD		30.69
CV%		7.28%
Date		*
LSD		21.70
CV%		7.28%
Date*Source		ns

-samples consist of ten berries each.
*denotes a significance level of $p \leq 0.05$)

Ito Farms:

While no significant difference was detected for fruit size based on either source or date, the mean fruit size from Outlook-sourced plant material was larger than the California-sourced material in 3 out of the 4 sampling dates (Table 6.9).

Table 6. 8 Ito Farms comparison of berry size between all locations throughout the duration of the harvest season.

Source	Date of Harvest	Mean Weight of Ten Fruit (g)*
California	20-Jan-00	293.0
Outlook	20-Jan-00	349.7
Ile a la Crosse	20-Jan-00	311.9
California	4-Feb-00	333.1
Outlook	4-Feb-00	349.7
Ile a la Crosse	4-Feb-00	361.5
California	29-Feb-00	387.2
Outlook	29-Feb-00	333.1
Ile a la Crosse	29-Feb-00	308.3
California	16-Mar-00	297.7
Outlook	16-Mar-00	340.2
Ile a la Crosse	16-Mar-00	316.6
Statistical Significance		
Source		ns
Date		ns
*Date*Source*		ns

*each sample is based on ten berries chosen at random.

Mandalay Farms. Similar to Ito Farms results, there were no significant differences for the sources of plant material (Table 6.10). However, LSD was high (92.09)and again, mean fruit size from Outlook-sourced plants was larger than California-sourced plants in 2 out of the 3 sampling times. A significant difference ($p \leq 0.01$) was noted for harvest date. February and March samplings had significantly higher fruit weights than those harvested in April. When the source*date of harvest interaction was compared significant differences were also found. The fruit from Outlook-sourced plants harvested in the first two months were greater than those harvested in the third month. California also produced higher fruit weights in the first two months when compared to April. Outlook-sourced plants in the first month were also significantly greater than the California plants in the first month.

Table 6. 9 Comparison of berry size over the duration of harvesting.

Source	**Date of Harvest**	**Mean Weight of Ten Fruit (g)**
California	8-Feb-00	337.0
Outlook	8-Feb-00	406.3
California	7-Mar-00	372.3
Outlook	7-Mar-00	393.0
California	4-Apr-00	260.0
Outlook	4-Apr-00	246.0
Statistical Significance		
Source		ns
Date		**
LSD		92.09
CV%		19.65%
Date*Source		**
LSD		48.12
CV%		9.21%

*denotes significance at $p \leq 0.05$

Table 6. 10 Summary of marketable fruit size and comparison between California-sourced and Southern Saskatchewan-sourced strawberry crowns.

Fruit Production Year	**California Location of Fruit Production**	**Source of Crowns**	**Mean Fruit weight (g/fruit)**			
			Jan. + Feb.	+/- %	End of season	+/- %
1997	Irvine, California (South Coast Research Station)	Norcal, CA	34		28	
		Saskatoon, SK	32	-6.2%	29	+3.5%
2000	Nakama Ranch, Oxnard, CA.	Fall River, CA	38.9		34.0	
		Outlook, SK	41.0	+5.4%	39.2	+15.3%
	Mandalay Farms, Oxnard, CA	Fall River, CA	33.7		26.0	
		Outlook, SK	40.6	+20.5%	24.6	-5.6%
	B&E Farms, Orange County, CA	Lassen Canyon, SK	31.3		29.7	
		Outlook, SK	35.0	+11.5%	34.0	+14.5%

+/- represents the percentage above or below California-sourced crowns.

6.3.3 Greenhouse Studies

Results from the greenhouse studies indicates originating location (Ile a-la Crosse, Meadow Lake and Outlook) is not a significant factor on flowering, fruit yield, days to runnering or the percentage of plants which runnered (Table 6.12).

Table 6. 11 Effect of source of planting material on flowering, fruit weight, days to runnering and runnering percentages tested under greenhouse conditions.

Treatment	Days to Flowering	Fruit Yield (g)	Days to Runnering	% Runnering
Ile a-la Crosse	54.4	21.0	23.4	40.0
Meadow Lake	56.6	18.7	38.8	30.0
Outlook	57.4	13.0	-	-
Statistical Significance	ns	ns	ns	ns
LSD	-	-	-	-
CV%	12.43	55.25	118	129

ns = nonsignificant at $p<0.05$.

At the conclusion of the experiment, dry biomass weights were taken (Table 6.13). A significant difference was noticed between the three locations. Plant material from Ile a-la Crosse location had a higher overall dry weight, while Outlook-sourced plant material had the lowest dry mass by the end of the experiment.

Table 6. 12 Effect of originating plant material on the dry weight (g) of strawberry plants after growing in the greenhouse for 4.5 months.

Treatment	Dry Weight (g)
Ile a-la Crosse	15.59
Meadow Lake	14.26
Outlook	10.93
Statistical Significance	**
LSD	2.17
CV%	18.14

**denotes significant at $p<0.05$ and $p<0.01$.

Further studies will have to be conducted using co-variance analysis to determine if the effects of initial plant size with the combination of location has any effect on days to flowering, and number of leaves produced (an indication of vigor).

6.4 Conclusions

The southern Saskatchewan site of Outlook, SK expressed inconsistent advantage in early yield over the period of this study. Unusually high fall temperatures during the 1999 and 2000 crown production season may have contributed to this response (Table 6.7). The most recent data from the 2001 crown production season (2002 fruiting year) indicate fruit yield had returned to the high levels of the 1996, 1997 and 1999 fruiting year observed for other locations.

A more consistent response was larger fruit size from Outlook-sourced crowns compared to California-sourced material over the years tested. Notably, crowns sourced from Outlook, SK appeared to maintain fruit size throughout the season compared to the majority of trends where fruit size decreased throughout the growing season. Fruit size was larger by an average of 7.8% in the first 2 months of harvest and by an average of 6.9% higher by the end of the season. This southern Saskatchewan location should continue to be monitored to determine if early yield advantage is more consistent.

7.0 Production of June-bearing Strawberry Crowns for Domestic Markets

7.1 Objective

The objective of this study is to determine if Saskatchewan can be a supplier of local crowns for spring planting in Canada. The widely planted June-bearing cultivar 'Kent' was chosen for this study. The most popular domestic strawberry cultivars grown in British Columbia were subsequently added. Crowns were purchased from two sources, the USA (Norcal Nurseries, CA) and a Canadian grower in Nova Scotia. A series of experiments were conducted to determine if differences exist between crowns from Canada and USA-sourced plant material both in the field and in storage conditions.

7.2 Materials and Methods

7.2.1 April 1998 – May 1999 Study

'Kent' crowns were planted from two sources, Norcal Nurseries (California, USA) and from Keddy's nursery (Nova Scotia, Canada). Enviro-Test Laboratories – Plains Innovative Laboratory Services conducted soil analysis and fertility adjustments were made accordingly. Crowns from both sources were planted in three locations, Outlook, La Ronge (55 ° 07' N Latitude) and Saskatoon, Saskatchewan (52°09' N Latitude), and maintained according to local cultural practices. Data was collected regarding the date of establishment, date of first runnering, date of flowering and number of leaves/plant at first runnering.

Daughter plants in La Ronge were dug on October 20th and 21st. Plants originating from Canada averaged 3 daughters per crown, while crowns from the USA averaged 8 daughters per crown. In Outlook, daughter crowns were dug on October 23rd. Canadian material averaged 10 daughters per mother crown and crowns from the USA averaged 6 daughters. In Saskatoon, harvest occurred on October 28th. Crowns from Canada averaged 7 daughters and USA crowns averaged 4 daughters per mother. Once harvested, the daughter crowns were placed into -2°C storage. Four replications consisting of ten crowns each were removed from cold storage at monthly intervals, starting November 1st and left to thaw overnight at 4°C. Crowns were planted in 4" x 4" pots filled with No. 4 'Sunshine' growing medium and grown at 16h daylengths at 22° ± 2°C day and 16 ± 2°C night temperatures in the greenhouse. Plants were fertilized with five hundred ppm (500mg/L) solution of 20:20:20 (N: P: K) at 25 ml/pot weekly. Plant material was shipped to the Pacific Agri-Food Research Center in Agassiz, B.C. in the spring of 1999. Fifty crowns of each source (USA or Canada) of each location (Outlook, Saskatoon, La Ronge) were sent for evaluation. New plant material from the USA and Canada was also sent to provide a control. An identical site was planted in Saskatoon, Saskatchewan on the 27th of May 1999 for evaluation. At this site the number of daughters was evaluated. In Saskatoon, daughters were harvested from 25 of the 50 crowns planted to provide production data.

Storage Study

The storage study consisted of four replications of ten crowns each which were removed from -2°C cold storage at 1, 4, 5 and 6 month intervals, starting December 1st and left to thaw overnight at 4°C. Crowns were planted in 4" x 4" pots filled with No. 4 'Sunshine' growing medium and grown at 16h daylengths at 22° ± 2°C day and 16 ± 2°C night temperatures in the greenhouse. Plants were fertilized with five hundred ppm (500mg/L) solution of 20:20:20 (N: P:

K) at 25 ml/pot weekly. Data was collected regarding the date of planting, date of flowering and number of leaves/plant at 2, 6 and 10-week intervals from the 1st of December 1998 until the 1st of May 1999 to indicate any changes in vigor. Plant material will be shipped to the Pacific Agri-Food Research Center in Agassiz, B.C. this spring. Fifty crowns from each source (USA or Canada) from each location (Outlook, Saskatoon, La Ronge) was sent for evaluation. New plant material from the USA and Canada was also sent to provide a control. An identical site was planted in Saskatoon, Saskatchewan for evaluation. Data was collected on flowering, runnering and yields.

7.2.2 1999-2000 Field Studies

Plant material was shipped to the Pacific Agri-Food Research Center in Agassiz, B.C. in the spring (1999) courtesy of Mr. Chaim Kempler from the Agriculture and Agri-Food Canada Pacific Agri-Food Research Centre. Fifty crowns of each source (USA or Canada) of each location (Outlook, Saskatoon, La Ronge) were sent for evaluation. New plant material from the USA and Canada was also sent to provide a control.

Crowns were planted on the 26th of May 1999 and maintained following the practices for the region. Data was collected on the 28th of July 1999 regarding the number of leaves, scapes and runners.

A) Agassiz, B.C.

This is a continuing study from 1998-1999. Plant material was to be shipped to the Pacific Agri-Food Research Center in Agassiz, B.C. in the spring (2000) after being stored at 0°C for the winter months; however, plant material was damaged during storage. Possible explanations for the loss in storage are that the plants were not fully hardened off before being harvested (not enough chilling hours accumulated).

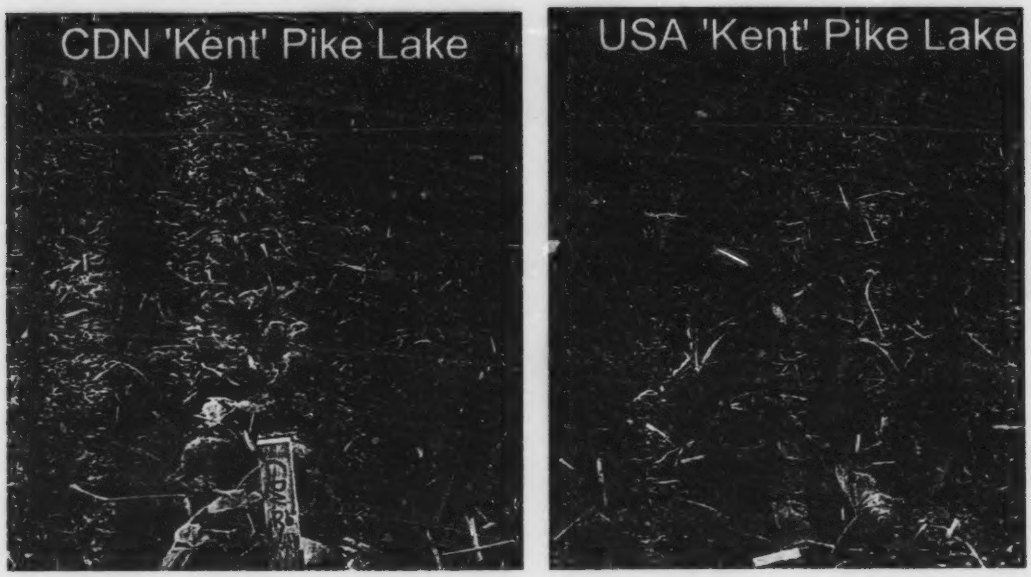
B) Pike Lake, SK.

Plant material was planted at the Pike Lake site in Saskatchewan., located approximately 50 km southwest of Saskatoon along the banks of the Saskatchewan River. The soil is a loam with a pH of 8.3 with a central irrigation pivot. Fifty crowns of the cultivar 'Kent' was received from two sources; one from the US (Lassen Canyon, in Redding California and one from Canada, (Simcoe, Ontario) (Fig. 7.1). 'Kent' was planted the 11th of May, 2000. Fertilizer was applied prior to planting according to soil analysis performed by Enviro-Test Laboratories – Plains Innovative Laboratory Services. Crowns were planted 30 cm apart within rows with a 1.5 m spacing between rows to allow for mechanical plot maintenance. Four replicates were planted consisting of 25 plants each. Upon inspection of the crowns, those received form the USA were in very poor condition. Throughout the box of crowns received, plants had started to break down and were covered with mycelium. The Canadian-sourced plants were very large and vigorous. The research plot was maintained following the recommended cultural practices for the region with irrigation occurring throughout the season as was deemed necessary. Establishment survival data was taken on the 2nd of August 2000.

C) La Ronge, SK.

Plant material was planted at the Potato Lake site near La Ronge, Saskatchewan on May 20, 2000 (Fig. 7.2). Fertilizer was applied prior to planting according to recommendations provided by Enviro-Test Laboratories – Plains Innovative Laboratory Services. Soil texture ranges from being a sandy loam to clay loam with pH variability from 6.5 to 8.0. Solid set irrigation is utilized with water filtered in from Potato Lake. Four replicates in RCBD (Randomized Complete Block Design) were planted consisting of 25 plants each on the 20th of May. Upon inspection of the crowns, those received form the USA were in very poor condition. Throughout the box of crowns received, plants had started to break down and were covered with mycelium.

Figure 7.1 'Kent' at Pike Lake on August 2nd , 2000.



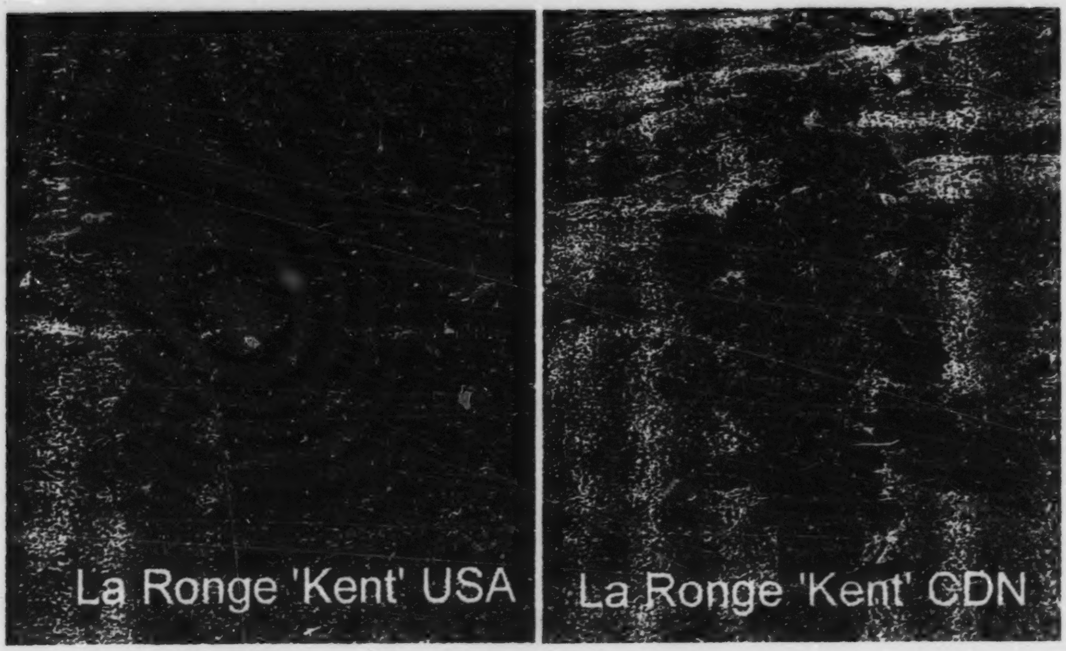


Figure 7.2 USA and Canadian 'Kent' crowns at La Ronge, SK. on July 7th, 2000.

D) Outlook

'Kent' was planted in Outlook on the 10th of May 2000. Planting consisted of four replicates of 25 plants each in RCBD. Plants were spaced 30cm apart with 1m between row widths. The research plot was maintained following the recommended cultural practices for the region with irrigation occurring throughout the season as necessary (Fig. 7.3). Poor growth was also noted at Outlook. The Canadian crowns were larger and healthier, however, still few daughters were produced. Due to the low numbers of daughter's, the plot was not harvested.

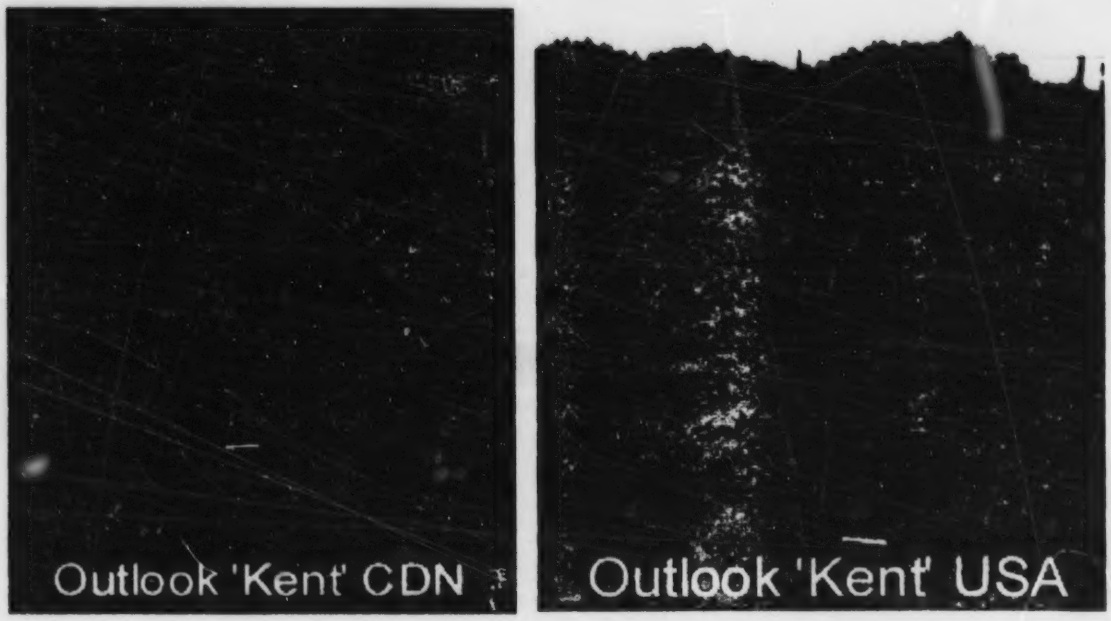


Figure 7.3 Canadian and USA 'Kent' at Outlook, SK. on the 23rd of July.

7.2.3 2000-2001 Strawberry Crown Storage Study

Crowns were placed in storage at 0°C in the fall of 1999 immediately after harvest. Cultivars included 'Totem', 'Puget Reliance', 'Sumas' and 89-61-39, which are four cultivars widely utilized in B.C. 'Kent' was also stored over the winter months. Plant material was to be shipped to Agassiz, B.C. for testing, however, all cultivars were lost during storage overwinter. Crowns were possibly not sufficiently hardened prior to harvest and therefore were not capable of withstanding storage conditions. New plant material was planted in the spring of 2000 for testing. The objective of the 2000-2001 storage study was to determine the optimum chilling hours for successful storage. Plant material tested consisted of 'Kent' and B.C. cultivars, 'Totem', 'Puget Reliance', 'Nanaimo' and 'Sumas'.

Four replicates of 25 'Kent' crowns were planted at three different sites in Saskatchewan; Outlook, La Ronge and Pike Lake on the 9th of May, 29th of May and 10th of May, 2000 respectively. The La Ronge planting date was later due to cool wet weather and frost. Fifty plants of each of the four B.C. cultivars were additionally planted at La Ronge and Pike Lake on the same dates as mentioned above. Fertilizer was applied prior to planting according to soil analysis performed by Enviro-Test Laboratories – Plains Innovative Laboratory Services. Plot maintenance and watering were applied following the region's cultural practices.

7.3 Results

7.3.1 Fruit Yield and Growth of Domestic Cultivars based on source and site of production of planting material.

1999 Agassiz, B.C. 'Kent' Field Study

A scape is a flowering stem growing from the root crown and not bearing proper leaves. A significant difference was noted between the number of scapes produced, the locations and origin combinations (Fig. 7.4, Table 7.1), however, due to the high CV%, there is high sample variation and leaf and runner numbers were not significantly different. It would, however, appear that newly purchased plant material stored at other commercial locations out-performed that which was stored under our conditions. For the Saskatchewan-stored material, plant material grown Outlook and originating from the Cdn sources had the highest scape number. There is little difference between the rest of the sites and the USA-sourced plant material at Outlook. The number of scapes can be used to determine which site/origin combination may have a greater yield potential the following season.

For the Saskatoon, Outlook locations and New plant material sourced from the USA and Canada, the general trend was for the Canadian crowns to out-perform USA-sourced plant material. Little difference is noted within the Saskatchewan locations.

Table 7.1 Leaf, scape and runner data of 'Kent' grown the previous season (1998) in La Ronge, Outlook and Saskatoon, SK and planted in Agassiz, B.C 1999 to determine the presence of locational effect compared to new plant material purchased within Canada and the USA.

Location of Growth	Plant Origin	Number of Leaves	Number of Scapes	Number of Runners
La Ronge	CDN	7.4	0.7	0.2
La Ronge	USA	6.3	0.8	0.6
Outlook	CDN	7.6	1.3	0.5
Outlook	USA	6.5	0.7	0.3
Saskatoon	CDN	7.0	0.7	1.0
Saskatoon	USA	5.9	0.7	0.3
New	CND	7.8	1.7	0.6
New	USA	6.3	1.5	0.7
Statistical Significance		ns	*	ns
LSD		-	0.5	-

† ns = not significant, * denotes significance level $p \leq 0.05$

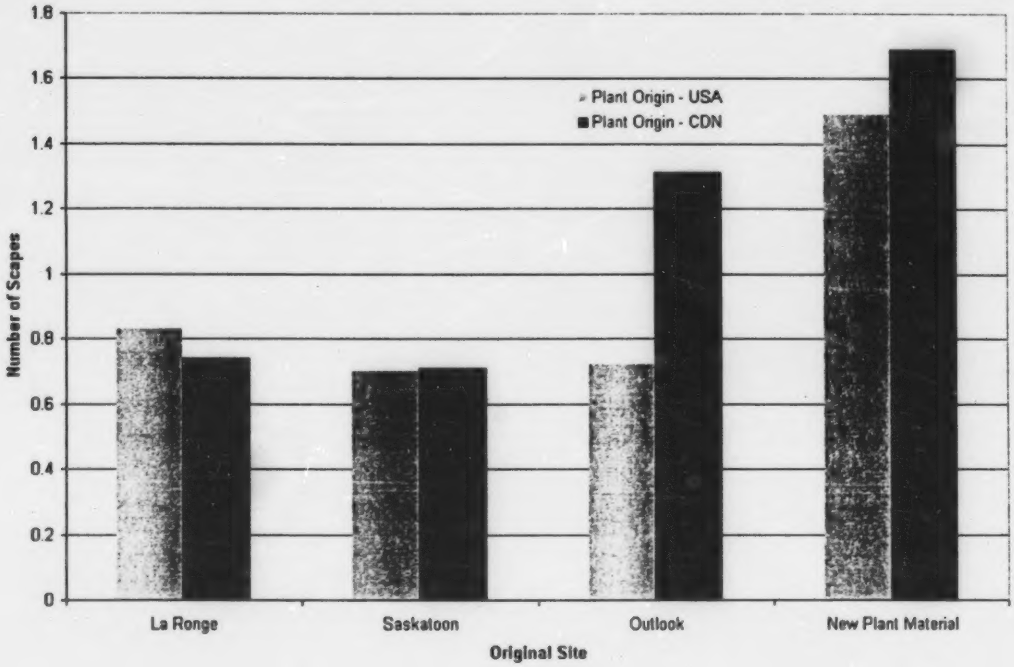


Figure 7. 4 The effect of site location and origin of plant material on the number of scapes produced.

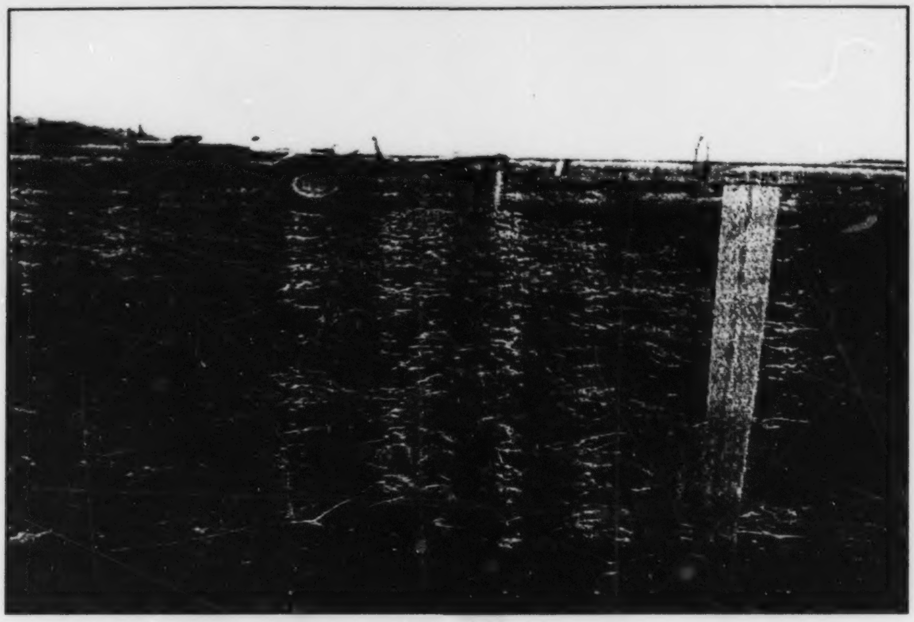


Figure 7.5 Outlook, SK 1999 Field Plot of B.C. Cultivars

Figure 7. 6 Row of 50 'Kent' plants originally grown in Saskatoon in 1998 and originated from Norcal Nursery, USA.

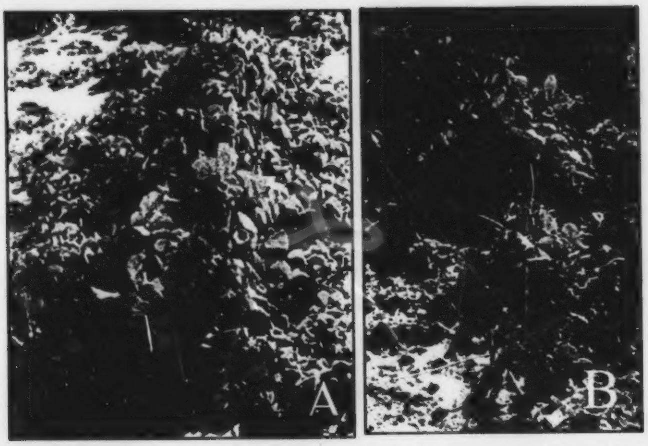


Figure 7. 7 Sumas' (A) and 'Puget Reliance' (B) domestic cultivars produced in Outlook, SK., 2000

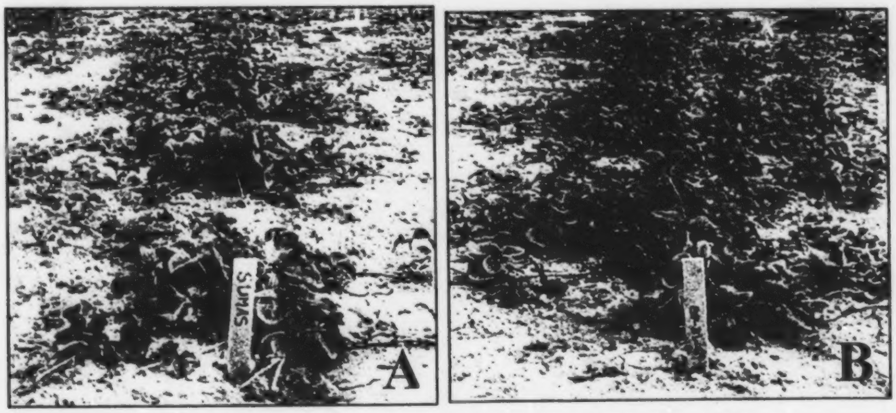


Figure 7. 8 'Sumas' (A) and '89-31-69' (B) strawberry plants at La Ronge, SK., 2000

Figure 7. 9 B.C. Cultivars 89-31-69 (A) and Totem (B) in Outlook, SK., 2000

Pike Lake, SK. 'Kent' & B.C. Cultivar Study

A significant difference exists between the two crown sources. Based on a chi-square analysis, the Canadian crowns had a significantly ($p \leq 0.01$) higher survival rate than the U.S.-sourced crowns (Table 7.2). This relates back to the quality of the crowns when they were first received.

The crowns from both sources (Canadian and U.S.) when grown in Pike Lake, SK did not produce sufficient daughter plants for harvest (Figs. 7.10, 7.11). The Canadian-sourced crowns produced runners, however, only 1-2 daughters were rooted and crown size was not sufficient for digging. The U.S.-sourced crowns produced very few runners and every 5th plant produced a daughter, however, they were also not of sufficient size for harvesting.

Table 7. 2 Crown survival after establishment for 'Kent' crowns from the USA and Canada planted at Pike Lake, SK, 2000.

Source	Average Survival %
USA	17
Canada	24.75
Statistical Significance	**
Chi-Square Value	6.6

** is significant at $p \leq 0.01$.

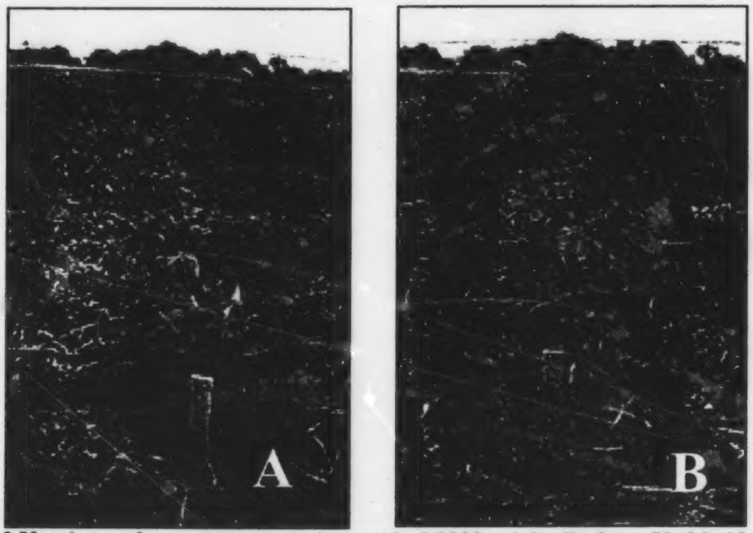


Figure 7. 10 Kent' strawberry crowns on August 2nd 2000 originally from Keddy Nursery, N.S. (A) and from Norcal Nursery, CA USA (B0 planted at Pike Lake, SK.

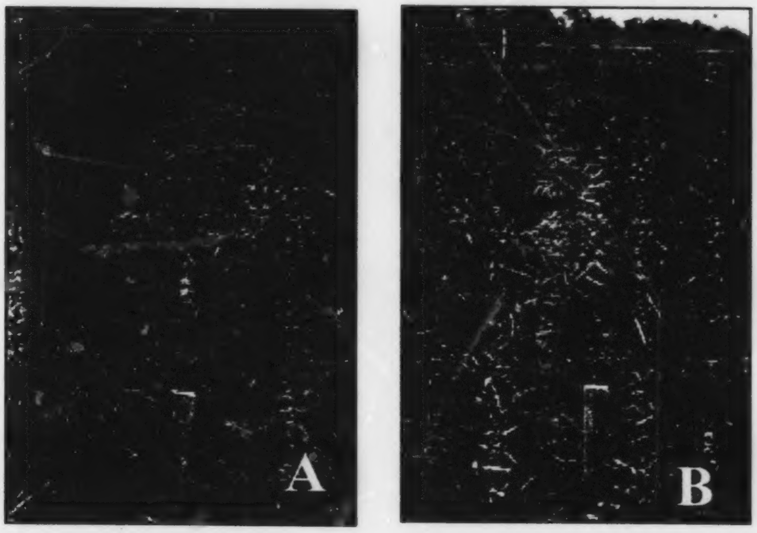


Figure 7. 11 Sumas' (A) and 'Totem' (B) strawberry crowns at Pike Lake, SK. on August 2nd, 2000

2000 La Ronge, SK. 'Kent' Study

Crown growth was slow at the La Ronge site (Figure 7.12). Crowns from both Canadian and U.S. sources did not produce sufficient daughter plants for harvest. The Canadian-sourced crowns produced runners, however, only 1-2 daughters were rooted and crown size was not sufficient for digging. The USA sourced crowns produced very few runners with little to no daughters produced.

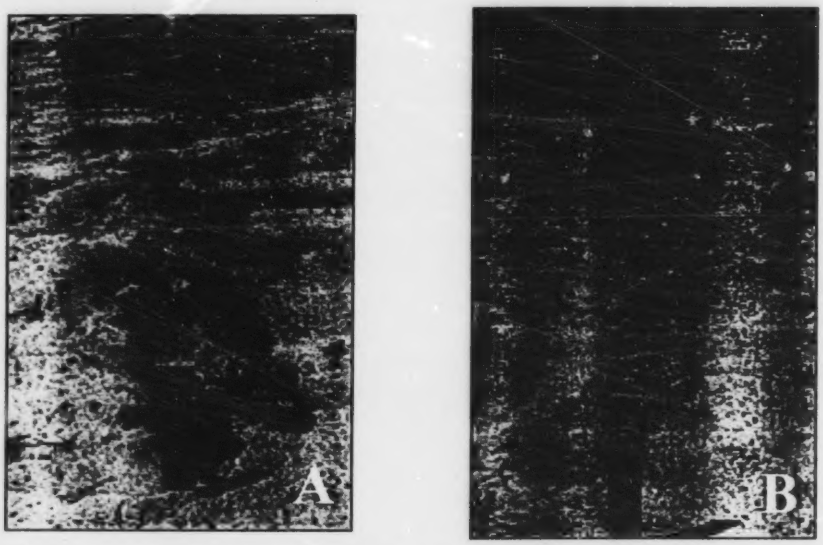


Figure 7. 12 USA and Canadian sourced 'Kent' crowns at La Ronge, SK. on July 7th, 2000.

2000 Outlook, SK. 'Kent' Study

Due to the poor growth and daughter numbers produced, only crowns from the Outlook location were harvested. Fifteen crowns were dug at weekly intervals from the 1st week in September until the last week of October. Crowns were trimmed immediately after digging, placed in a plastic bag and taken to the College of Agriculture Greenhouses. Ten plants were placed in a 1°C cooler for storage in a plastic bag. These crowns were removed from storage in the spring of 2001 and survival was recorded.

Figure 7. 13 'Kent' plot in Outlook, SK on July 23rd, 2000.

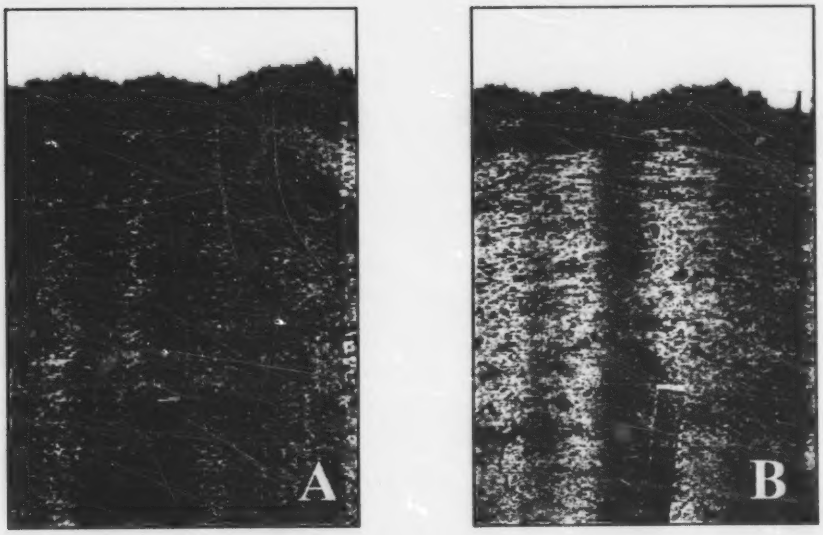


Figure 7. 14 USA and Canadian 'Kent' strawberry crowns in Outlook. SK on July 23rd, 2000

7.3.2 Storability of domestic cultivars

The various storage treatments had a significant effect on the number of days until flowering was initiated (Table 7.2, Fig. 7.15). The general trend was for a decline to occur in the number of days until flowering as the length of time in storage increased. One month and four months in storage had no significant difference (36-38 days), however, at five months in storage, the days to flowering decreased to 33 days and further decreased to 22 days after six month in storage. A possible explanation is that the chilling requirements for the strawberry plants are increasingly being met over the duration of the storage period. As the requirements for chilling are being met, the number of days until flowering decreases.

The duration in storage also had a significant effect on the number of leaves produced (Table 7.2, Fig. 7.17). At two-week leaf counts, plant material stored for six months had the greatest number of leaves. The general trend was for strawberry plants to increase the number of leaves produced two weeks after planting from the first month of storage onwards. Six week leaf counts saw a significant decrease in plant material stored for five months as compared to those planted at one and four month intervals. There was a significant increase in the number of leaves produced when plants were stored for six months. Ten weeks after planting, strawberry crowns stored for six months produced the greater number of leaves, however there was an unusual decrease in leaf numbers at the fourth month of storage.

There were no significant differences in the survival rate of the crowns under storage (Table 7.2). From all locations there was between a 97.5-100% survival rate of stored crowns. There was also no significant difference between any of the locations and their origins. The variance in the Four-Week leaf number during the 5th month in storage has no explanation. Crowns performed better after being in storage for six months by producing a greater number of leaves and having a significant decrease in the number of days for flowering to begin. No vigour had been lost, and Canadian plant material is comparable to material purchased from the USA, therefore producers may grow locally instead of importing planting stock. However, subsequent tests indicate date of harvest is important since lack of chilling may negatively influence storability of crowns. Temperature of storage is also an important consideration and storage temperature should be as close to 0C as possible with little temperature fluctuation.

Table 7.2 The effect of various storage duration's on the vigor of 'Kent' strawberry crowns.

Treatment (months in storage)	Location of Growth	Plant Origin	Days to Flower	Survival	Leaf No. at 2 Weeks	Leaf No. at 6 Weeks	Leaf Number at 10 Weeks
1	Saskatoon	CDN	29	100%	1.6	4.5	6.9
	Saskatoon	USA	35	100%	1.8	4.3	6.3
	Outlook	CDN	37	97.5%	2.1	4.6	7.4
	Outlook	USA	35	97.5%	1.9	4.5	6.8
	La Ronge	CDN	37	100%	2.0	4.7	7.0
	La Ronge	USA	36	100%	1.9	4.3	6.6
4	Saskatoon	CDN	37	100%	2.5	4.3	6.0
	Saskatoon	USA	37	100%	2.6	4.5	5.8
	Outlook	CDN	42	100%	2.5	4.4	6.3
	Outlook	USA	39	100%	2.6	4.3	5.5
	La Ronge	CDN	33	100%	2.9	4.4	6.1
	La Ronge	USA	38	97.5%	2.5	4.2	6.1
5	Saskatoon	CDN	33	100%	2.4	2.5	6.9
	Saskatoon	USA	34	100%	2.4	2.5	7.2
	Outlook	CDN	33	100%	2.3	2.3	7.8
	Outlook	USA	33	100%	2.2	2.2	7.4
	La Ronge	CDN	33	100%	2.2	2.3	7.3
	La Ronge	USA	34	100%	2.2	2.3	7.3
6	Saskatoon	CDN	21	100%	3.4	7.0	8.9
	Saskatoon	USA	23	100%	3.2	7.3	8.3
	Outlook	CDN	23	100%	3.6	7.2	10.3
	Outlook	USA	21	100%	3.4	7.7	9.6
	La Ronge	CDN	21	100%	2.5	7.5	8.1
	La Ronge	USA	23	100%	3.1	7.5	9.0
Statistical Significance							
Location			ns	ns	ns	ns	ns
Origin			ns	ns	ns	ns	ns
Treatment			*	ns	*	*	*
Location*Origin			ns	ns	ns	ns	ns
Location*Treatment			ns	ns	ns	ns	ns
Origin*Treatment			ns	ns	ns	ns	ns
Location*Origin*Treatment			ns	ns	ns	ns	ns
Lsd $_{0.05}$							
Lsd for Treatment			1.74	-	0.34	0.16	0.44

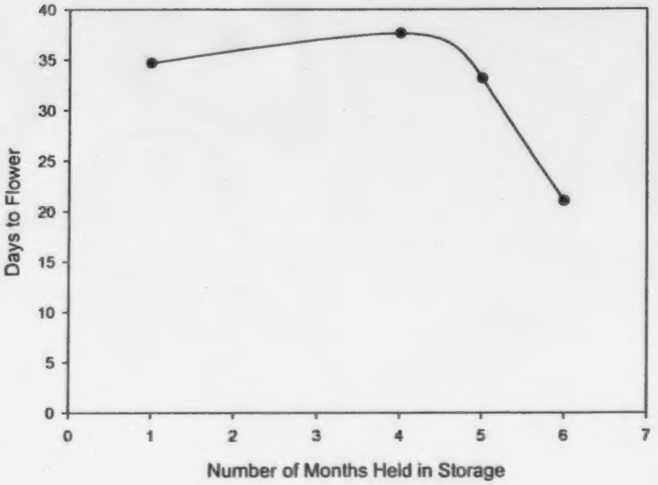


Figure 7.15 The effect of storage duration on the number of days until flowering is initiated in 'Kent' strawberry plants.

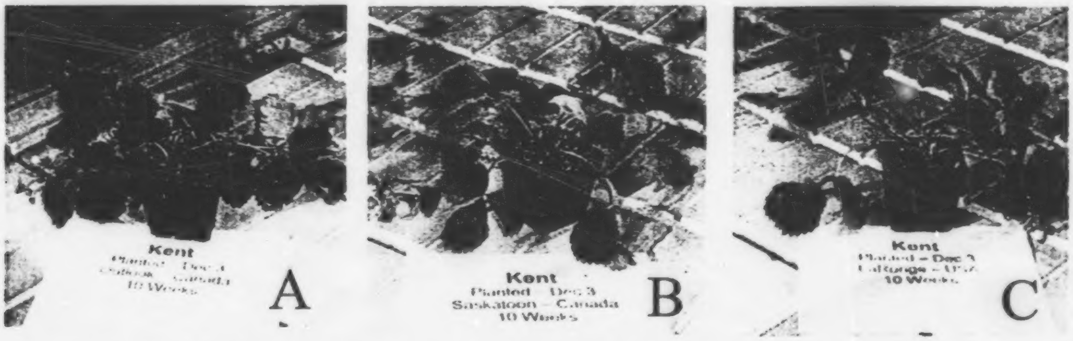

Kent
A
Kent
Planted Dec 3
Saskatoon – Canada
10 Weeks
B
Kent
10 Weeks
C

Figure 7. 16 Outlook (A), Saskatoon (B) and La Ronge (C) sourced 'Kent' strawberry crowns after being treated to 1 month of -2 C storage and grown for ten weeks in the greenhouse.

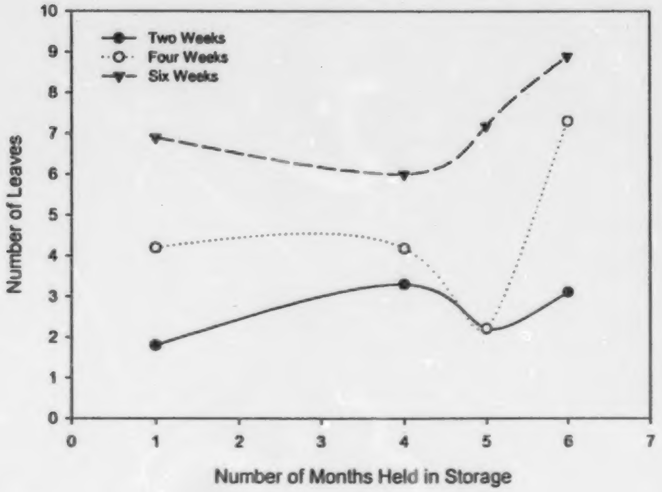


Figure 7. 17 The effect of storage on the number of leaves produced at two, four and six week intervals of 'Kent' strawberry plants.

7.3.3 Transplant Survival

Transplant survival data was taken on the 2nd of August 2000 (Table 7.3). A significant difference existed between the two crown sources. Based on a chi-square analysis, the Canadian crowns had a significantly ($p \leq 0.01$) higher survival rate than the American sourced crowns. This relates back to the quality of the crowns when they were first received where U.S.-sourced crowns had considerable mycelial growth.

The crowns from both locations did not produce sufficient daughter plants for harvest. The Canadian sourced crowns produced runners, however, only 1-2 daughters were rooted and crown size was not sufficient for digging. The USA sourced crowns produced very few runners and every 5th plant produced a daughter, however, they were not of sufficient size for harvesting.

Table 7. 3 Crown survival for 'Kent' crowns from the USA and Canada planted at Pike Lake, SK.

Source	Average Survival %
USA	17
Canada	24.75
Statistical Significance	**
Chi-Square Value	6.6

** is significant at $p \leq 0.01$.

7.3.4 Daughter Crown Production of Domestic Cultivar 'Kent'

In Saskatoon, Saskatchewan crowns were planted on the 27th of May 1999 for evaluation of the potential crown yields, and the number of daughters. In Saskatoon, daughters were harvested from 25 of the 50 crowns planted to provide production data.

For the Saskatoon, Outlook and New plant material from the USA and Canada, the general trend was for the Canadian crowns to out-perform USA plant material (Fig. 7.18). Little difference is noted within the locations of the planting material. Plant material which had previously been planted in La Ronge originating from the USA produced the greatest number of daughters, however, the La Ronge Canadian plant material had difficulties establishing as a section of the row was accidentally removed by field staff on two occasions. Therefore it is not known for certain that the Canadian plant material may not have followed the general trend and produced a higher number of daughters. Re testing will have to be done to determine what the number of daughter's from La Ronge would be with proper establishment.

Table 7.4 indicates about double the number of daughters is produced in the second year. While there is no significant difference between source, the U.S.-sourced material produced a greater number of daughters than the Canadian-source. Overwintering the daughters and harvesting in the second year appears to be a more viable option for growers.

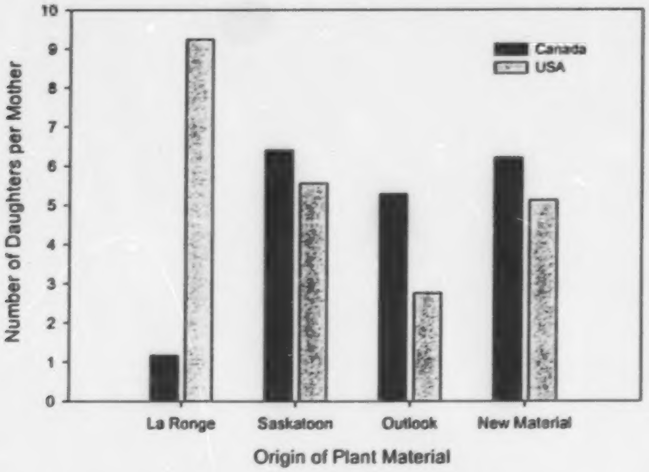


Figure 7. 18 Number of 'Kent' daughter plants produced by strawberry crowns stored and planted in the spring of 1999 after being treated to three various latitudes (La Ronge, Saskatoon, Outlook) from two origins, (Canada & USA) the previous season (1998).

Table 7.4 The number of 'Kent' daughters produced within a 1mx1m area consisting of 3 mother crowns in Saskatoon, SK.

Original Source	Number Daughters
La Ronge Canadian	34.00
La Ronge USA	36.25
Outlook Canadian	32.25
Outlook USA	42.00
Saskatoon Canadian	32.75
Saskatoon USA	41.50
New Canadian	34.50
New USA	31.50
Statistical Significance	ns
† ns = not significant	

Table 7. 5 Difference noted between location and B.C. cultivars when comparing the number of daughters produced per mother

Cultivars	La Ronge # Daughters	Outlook # Daughters
Totem	4.0	7.0
Puget Reliance	4.8	6.0
Sumas	4.3	6.4
89-31-69	6.0	7.6

A greater number of daughters were produced at Outlook when compared to the La Ronge numbers (Table 7.5). Cultivar 89-31-69 produced the greatest number at all the plots; therefore cultivar differences do exist between the various strawberry types.

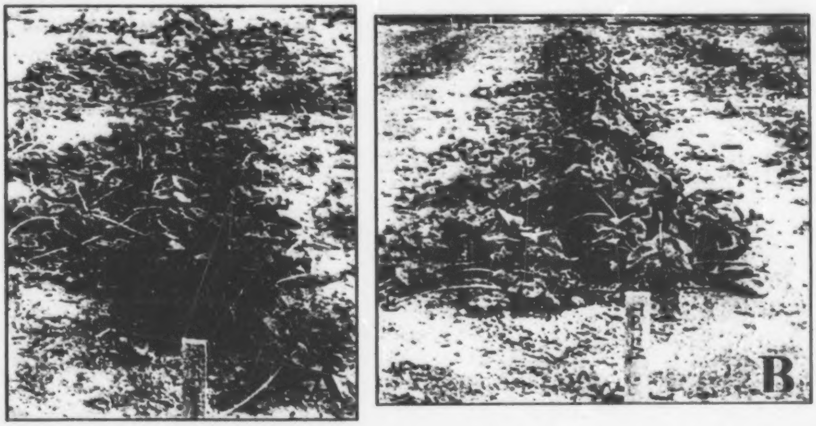


Figure 7.19 'Puget Reliance' (A) and 'Totem' (B) strawberry plants in La Ronge, SK.

7.4 Conclusions

Production of crowns for domestic markets is potentially viable and will likely result in increased crown quality through a reduced incidence of disease. However, several factors should be addressed: appropriate harvest time in the fall to ensure sufficient chilling has been received by the crowns before harvest; overwintering the crowns and harvest in the second year of production; select location of crown production based on optimizing daughter yield and not simply based on latitude; select crowns for production based on productivity which will vary with cultivar; ensure appropriate and stable temperature storage conditions.

8.0 Hormonal Application on 'Camarosa' Strawberry Crowns

8.1 Objective

Tissue culture has been a vegetative propagation method extensively used in most horticultural crops to obtain virus-free initial material for further multiplication. Previously studies have indicated that addition of cytokinins into tissue culture medium can significantly increase both runner and crown production in strawberries when grown under both greenhouse and field conditions. This additional beneficial effect of cytokinins may be utilized as a means of enhanced crown production under field conditions. As an initial step, this study was established to evaluate the dose response to cytokinins added to the tissue medium in terms of the runner and crown production of the subsequent generation of strawberry crowns grown in field conditions.

8.2 Materials and Methods

Our previous studies have indicated treatment combinations of GA_3 at 200mg+benzyladenine at 250mg/L applied to strawberry plantlets as a soil drench at 1 or 2 mL/plant, increased crown production in strawberries following the field planting. Further study was conducted to evaluate the effect of treatments applied as a crown soak at different duration's (0 – control, 12, 18 and 24 hours), on crown production of 'Camarosa' strawberries. After the crown soak treatment, strawberry crowns were planted in the field on May 20th, 1998 at the Horticulture Field Lab Research Test Plots, University of Saskatchewan, Saskatoon, and maintained following the recommended cultural practices for the region.

The greenhouse study involved the cultivar 'Camarosa'. Two methods of application were utilized; soil drench and crowns soaked in hormonal solutions. Each method consisted of five separate treatments applied to five strawberry crowns each. The treatments were:

a) Soil Drench
    - Control (water + surfactant; Tween 20 at 0.01%)
    - GA_3 (200mg) + benzyladenine (BAP) 250mg/L + Tween 20 – 1 mL/pot
    - GA_3 (200mg) + benzyladenine (BAP) 250mg/L + Tween 20 – 2 mL/pot
    - GA_3 (200mg) + kinetin 250mg/L + Tween 20 – 1 mL/pot
    - GA_3 (200mg) + kinetin 250mg/L + Tween 20 – 2 mL/pot

b) Crown Soaked
    - Control (water +surfactant)
    - GA_3 (10mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20 — 12h
    - GA_3 (10mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20 — 12h
    - GA_3 (20mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20 — 12h
    - GA_3 (20mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20 — 12h

In the greenhouse study, plants were grown with 12h or 16h day-lengths with a day temperature of $22^0 \pm 2^0C$ and night temperatures of $16^0 \pm 2^0C$ (Table 8.1). Plants were fertilized with five hundred ppm (500mg/L) solution of 20:20:20 (N:P:K) at 25 mL/pot weekly.

Table 8.1 GA3 (10 or 20mg) and benzyladenine (12.5mg/L or 25.0mg/L) concentration combinations were tested for 12, 18 and 24 hour duration's on 'Camarosa' strawberry crowns and exposed to growing conditions of either 12 or 16 hour days at the Agriculture Greenhouses in 1998

Treatment A Hormone Concentrations	**Treatment B** Duration of Crown Soaking (hours)	**Treatment C** Daylength (hours)
Control (water +surfacant)	12	12
GA_3 (10mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	12	12
GA_3 (10mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	12	12
GA_3 (20mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	12	12
GA_3 (20mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	12	12
Control (water +surfacant)	18	12
GA_3 (10mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	18	12
GA_3 (10mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	18	12
GA_3 (20mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	18	12
GA_3 (20mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	18	12
Control (water +surfacant)	24	12
GA_3 (10mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	24	12
GA_3 (10mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	24	12
GA_3 (20mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	24	12
GA_3 (20mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	24	12
Control (water +surfacant)	12	16
GA_3 (10mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	12	16
GA_3 (10mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	12	16
GA_3 (20mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	12	16
GA_3 (20mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	12	16
Control (water +surfacant)	18	16
GA_3 (10mg) + benzyladenine (BAP) 12.5 mg/L +	18	16

Tween 20		
GA_3 (10mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	18	16
GA_3 (20 mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	18	16
GA_3 (20mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	18	16
Control (water +surfacant)	24	16
GA_3 (10mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	24	16
GA_3 (10mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	24	16
GA_3 (20 mg) + benzyladenine (BAP) 12.5 mg/L + Tween 20	24	16
GA_3 (20mg) + benzyladenine (BAP) 25.0 mg/L + Tween 20	24	16

Measurements and observations for both field and greenhouse studies consisted of date of establishment, date of first runnering, number of leaves/plant at first runnering, total number of daughters/plant at 3 months after planting and number or rooted and unrooted daughters /plant 3 months after planting.

Tissue culture application: various rates of BAP (benzyladenine) included 1mg/L, 0.25mg/L, 0.5mg/L and no BAP. BAP was applied to the strawberry media on the 7th of March, 2000. On April 10th, 2000, the strawberries were removed from culture and planted into a small plug tray containing SunShine Mix #5. The tray was placed in a mist chamber for two weeks and then was removed to a 25°C bench. Plants were fertilized once a week with five hundred ppm (500mg/L) solution of 20:20:20 (N:P:K). Once roots grew throughout the plug tray, the strawberries were transplanted to larger plugs and then were field planted in the spring of 2001.

8.3 Results

8.3.1 Crown Soak Hormonal Application

Within the 12, 18, and 24-hour crown soak treatments, all plant material died due to the high concentrations of both hormones.

8.3.2 Soil Drench

The experiment was concluded on February 9, 1999 after visual observations noted little difference between treatments. This experiment was not re-conducted. Focus was placed on the strawberries in the other tissue culture study to determine the effects of cytokinins on plant production and runnering (ADF grant # 99000071).

8.3.3 Greenhouse study

Cytokinin concentrations were found to be toxic. Stunting in treated plant material occurred within both day-lengths when compared to the control. This treatment was re-tested in field conditions during the summer of 1999 to determine proper levels of cytokinins and to obtain data as was mentioned above.

8.4 Conclusions

Cytokinin treatment either as a crown soak or soil drench was not effective and was toxic to the crowns in spite of the wide range in concentrations tested. Tissue culture treatment may be the only effective method to use this hormone treatment.

9.0 Timing of Harvest and Earliness in Fruiting of Strawberries

9.1 Objective

It is assumed that Saskatchewan-grown crowns initiate flower buds and fulfill their chilling requirements earlier than those produced in California. Testing this hypothesis is addressed by another ADF project in progress. As a result, Saskatchewan-grown crowns may flower earlier and produce significantly higher fruit yield and fruit size than those produced by California-grown crowns, particularly during the first two months of the fruiting season. It is not known, however, how early the Saskatchewan-grown crowns can be harvested without losing their productive advantages. This study therefore, was established to evaluate the impact of timing of harvest on earliness in flowering and fruiting of Saskatchewan-grown crowns.

9.2 Materials and Methods

'Camarosa' crowns were planted on June 4th, 1998 at LaRonge, Saskatchewan (55°.07' N Lat.). Soil analysis was conducted prior to planting and fertility was adjusted according to the recommendations of Enviro-Test Laboratories – Plains Innovative Laboratory Services. Plants were maintained with cultural practices recommended for the region with irrigation occurring as necessary. Forty strawberry crowns of the cultivar 'Camarosa' were dug randomly from the site beginning the first week of September and sampled weekly thereafter until the second week of October. Crowns were immediately shipped to Saskatoon where the daughters were trimmed and planted in 4" x 4" pots filled with No. 4 'Sunshine' growing media. Crowns were grown in the College of Agriculture greenhouses with a daylength of 16 hr. Daytime temperatures consisted of 22° ± 2°C and night temperatures of 16° ± 2°C. Plants were fertilized with a five hundred ppm (500mg/L) solution of 20:20:20 (N:P:K) at 25mL/pot weekly. Measurements and observations consisted of date of establishment, date of first runnering, number of leaves/plant at first runnering, date of flowering, total number of daughters/plant at 3 months after planting and number of rooted and unrooted daughters /plant 3 months after planting.

9.3 Results

Crowns harvested and planted on September 4th and September 11th showed significantly earlier flowering, however, the percentage which flowered was quite low (Fig. 9.1, Table 9.3). High variation in % flowering response, however, prevented detection of significant differences between sampling dates. Data for the September 16th planting and harvest was not collected since the plant material was damaged during transit from La Ronge to Saskatoon. The next data set for September 24th indicates 100% of the plants flowered before flowering numbers dropped off during the October 5th and October 9th digging. Surprisingly in 1998, days to flower increased with time, however this response was not significant (Table 9.3). Conversely, in the year 2000, days to flower significantly decreased with time (Table 9.4) which is consistent with our other observations. Generally, flowering is advanced the later the harvest date and results in a linear decline in time to first flower (Fig. 9.5). Results on location of crown production were also variable in that evidence both indicated influence of time to flower (Fig. 9.4) and evidence where location did not influence this response (Table 9.1). There was high variation in response and looking at the mean values in conjunction with our other results, it appears that location likely does influence time to first flower and probably depends on the temperature regime at that location for that year (Fig. 9.4). In general, optimum harvesting might occur during the third week of September without causing a decrease in crown productivity.

Location of crown production also indicated no significant effect on fruit yield, days to runnering and runnering percentage when those crowns were subsequently grown in the greenhouse. However, cv was high and Ile a la Crosse expressed the highest fruit yield of the sites tested. This result is consistent with Table 9.2 where the highest dry weight of crown growth under greenhouse conditions was observed at the Ile a la Crosse site.

Table 9.1 Effect of location on flowering, fruit weight, days to runnering and runnering percentages of 'Camarosa' in greenhouse conditions in 1998.

Treatment	Days to Flowering	Fruit Yield (g)	Days to Runnering	% Runnering
Ile a-la Crosse	54.4	21.0	23.4	40.0
Meadow Lake	56.6	18.7	38.8	30.0
Outlook	57.4	13.0	-	-
Statistical Significance	ns	ns	ns	ns

† -ns = not significant.

Table 9.2 Effect of location on the dry weight (g) of 'Camarosa' strawberry plants after growing in the greenhouse for 4.5 months.

Treatment	Dry Weight (g)
Ile a-la Crosse	15.59
Meadow Lake	14.26
Outlook	10.93
Statistical Significance	**
LSD	2.17

† **denotes significant at $p \leq 0.01$.

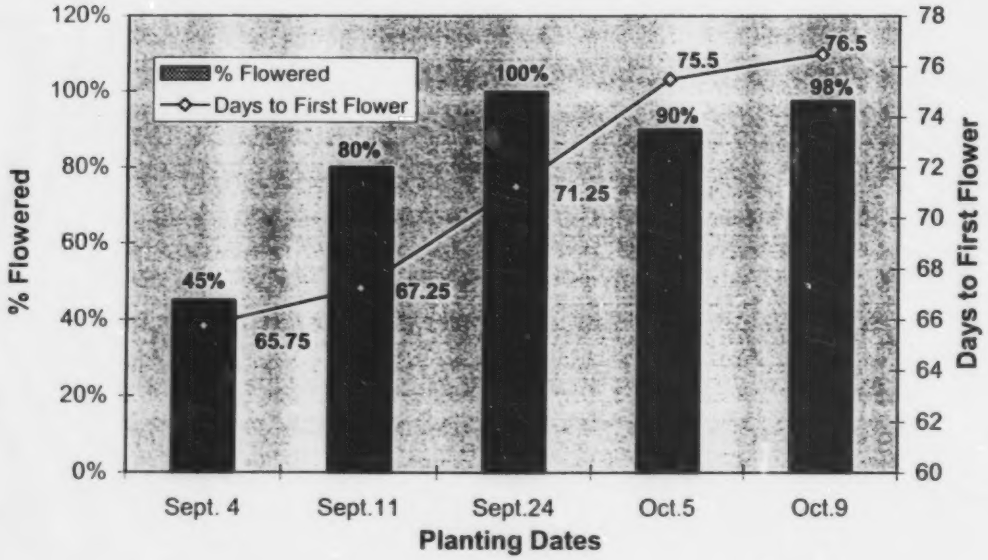


Figure 9. 1 'Camarosa' strawberry crowns harvested from La Ronge, SK. at staggered intervals from September 4th to October 9th 1998.

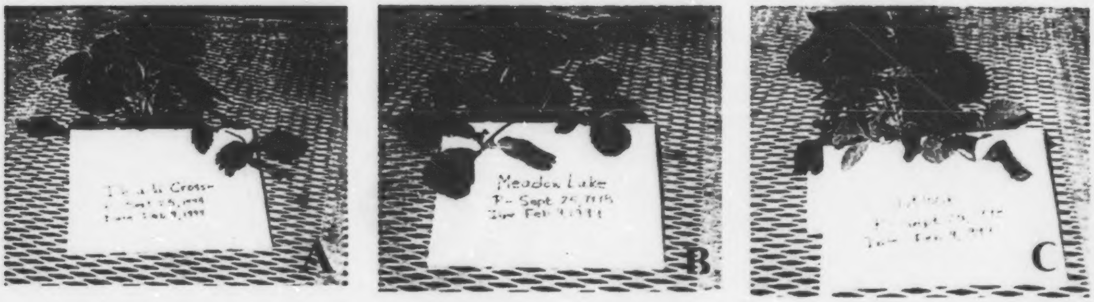


Figure 9. 2 'Camarosa' plants tested from Ile a la Crosse (A) Meadow Lake (B) and Outlook (C) in the College of Agriculture Greenhouses, University of Saskatchewan 1998 – 1999.

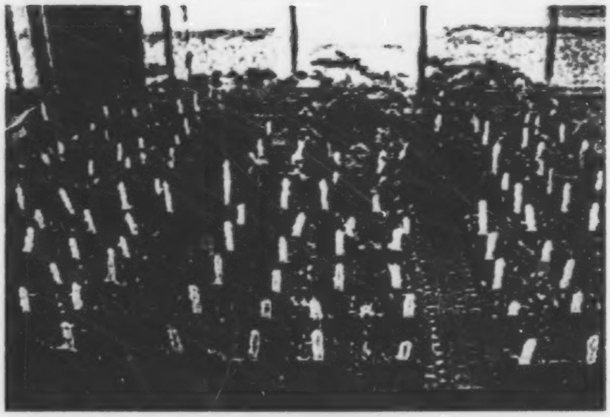


Figure 9. 3 Staggered harvest study of 'Camarosa' crowns being conducted in the College of Agriculture Greenhouses, University of Saskatchewan.

Table 9. 3 Combined Analysis of 1998 and 2000 days to flowering data

Year	Treatment Harvest Week	Mean No. of Days to Flowering
1998	September Week 1	69.0
1998	September Week 2	68.8
1998	September Week 3	70.5
1998	September Week 4	74.0
1998	October Week 1	74.0
2000	September Week 1	74.8
2000	September Week 2	68.5
2000	September Week 3	64.3
2000	September Week 4	59.8
2000	October Week 1	54.8
Statistical Significance		
Year		ns
Treatment		ns
Year*Treatment		**
LSD		9.66

† ** denotes significance of $p \leq 0.01$, ns = not significant

2000

Table 9. 3 Determining the n number of days until flowering occurs when harvested at staggered dates from three locations.

Location	Treatment Harvest Date	Mean No. of Days to Flowering
La Ronge, SK.	September 6	74.8
La Ronge, SK.	September 11	68.5
La Ronge, SK.	September 20	64.3
La Ronge, SK.	September 27	59.9
La Ronge, SK.	October 4	54.8
La Ronge, SK.	October 18	54.0
La Ronge, SK.	October 25	46.3
Outlook, SK.	September 6	73.3
Outlook, SK.	September 11	72.8
Outlook, SK.	September 20	57.5
Outlook, SK.	September 27	58.3
Outlook, SK.	October 4	51.9
Outlook, SK.	October 18	49.9
Outlook, SK.	October 25	43.5
Pike Lake, SK.	September 6	66.8
Pike Lake, SK.	September 11	67.9
Pike Lake, SK.	September 20	57.4
Pike Lake, SK.	September 27	51.2
Pike Lake, SK.	October 4	49.9
Pike Lake, SK.	October 18	51.1
Pike Lake, SK.	October 25	46.5
Statistical Significance		
Location		*
LSD		2.12
Treatment		**
LSD		4.94
Location*Treatment		ns

† * denotes significance of $p \leq 0.05$, ** denote significance of $p \leq 0.01$, ns = not significant

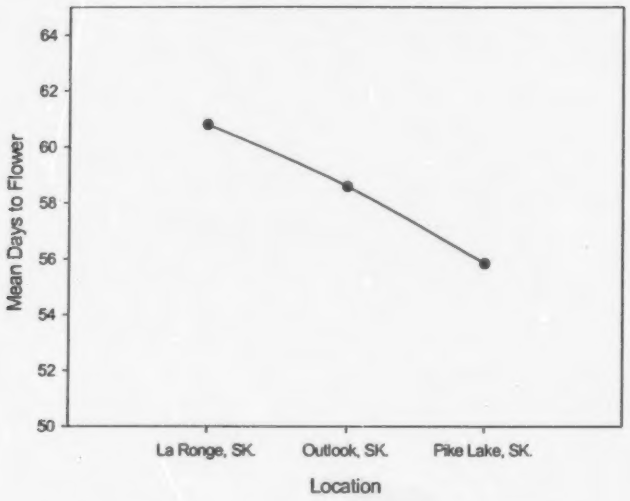


Figure 9. 4 Mean days to flower for the locations of La Ronge, Outlook and Pike Lake all within Saskatchewan

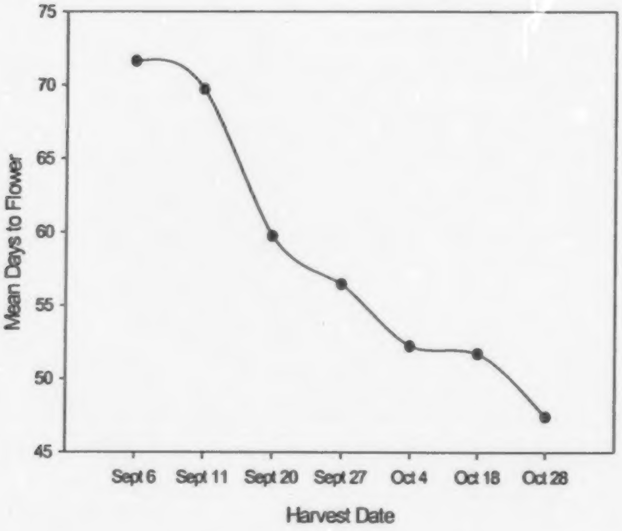


Figure 9. 5 Means days to flower compared to the various harvest dates extending from September 6th to October 25th, 2000

9.4 Conclusions

Flowering time was generally advanced the later the harvest date. This is consistent with our other observations where increased crown exposure to chilling requirement induced higher marketable fruit yield in the first 2 months of harvest.

10.0 Size of Crowns and De-blossoming

10.1 Objectives

The California market currently has no sizing standards in place. Crowns that are larger than the width of a pencil, however, are considered acceptable. One of the objectives of this study was to determine the effect crown size on growth and fruit yield of 'Camarosa' under greenhouse conditions.

De-blossoming newly planted crowns is thought to increase the runner production of strawberry plant material. However, de-blossoming is usually done utilizing field labour. This method can be expensive and time consuming. This study will determine whether de-blossoming strawberries increases runner production sufficiently to warrant the continuation of this method.

10. 2 Materials and Methods

On September 24, 1998, 'Camarosa' plants were harvested randomly from the mass production field in LaRonge, Saskatchewan. Sixteen daughter plants were sized for each grouping of small, medium and large. Crowns were planted in 4" x 4" pots filled with No.4 'Sunshine' medium and are being fertilized with five hundred ppm (500mg/L) solution of 20:20:20 (N:P:K) at 25 mL/pot weekly. Daylength was 16 hr with day and night temperatures consisting of $22^{\circ}C \pm 2^{\circ}C$ and $16^{\circ}C \pm 2^{\circ}C$ respectively. Observations consist of date of establishment, survival number at one month, date of first runnering, number of leaves/plant at first runnering and date of flowering.

A comparison will be conducted on crowns de-blossomed versus those that were not de-bloomed with 25 crowns per treatment. Plant material was planted on May 27th, 1999 at the Department of Plant Sciences Field Lab in Saskatoon. Crowns were harvested on the 29th of September 1999 and the daughters were counted.

10.3 Results

10.3.1 Sizing of Crowns on Subsequent Yield

This study was concluded on December 10, 1998. Crown size had no effect on flowering, survival or the runnering of the strawberry plant material (Table 10.1). There was a significant difference in the size of the crowns at the time of the studies conclusion but this did not affect the other factors being studied.

Table 10. 1 Effect of crown size on flowering, survival and runnering of 'Camarosa' in greenhouse conditions.

Treatment 1998	Days to Flowering	% Flowering	Days to Runnering	Crown Size	% Runnering	% Survival
Small (root buds)	65	53	42	0.8	73	26
Medium (<1")	64	80	18	1.2	100	20
Large (>1")	64	80	9	1.6	80	20
Statistical Significance	ns	ns	ns	**	ns	ns
LSD	-	-	-	0.22	-	-

† - ns = not significant, ** significant at $p \leq 0.01$

10.3.2 De-blossoming Study

De-blossomed plants produced 5.2 daughters while those with the daughters left on produced 5.36 crowns (Table 10.2). No significant difference is noted.

Table 10. 2 The effect of blossom removal on the number of daughter's produced.

	# of Daughters	# of Daughters / Mother
Blossoms Removed	130	5.20
Blossoms Remained	134	5.36

Although no significant difference was noted, this study was re-evaluated in the spring of 2000. Plants tested were chlorotic throughout the growing season, which could have affected the final results.

A comparison was re-conducted on crowns de-blossomed versus those that were not. Treatments of deblossomed and control, consisted of 10 crowns for each of the four replicates in RCBD. Plant material was planted on May 16th, 2000 near Pike Lake, Saskatchewan located 20 minutes south of Saskatoon. Before the crowns were established, soil samples were taken to determine the N, P, K and S status. Soil analysis indicated that the soils is a loam with a pH of 8.3 and was marginal in NO_3^-N and deficient in P_2O_5. Nitrogen and phosphorous were added for an overall soil nutrient availability to 120lbs/ac of each nutrient. Crowns were harvested on the 26th of September 2000 and the number of rooted and unrooted daughters were counted. There were no significant differences between treatments (Table 10.3).

Table 10. 3 The effect of blossom removal on the number of daughter's produced in 2000.

Treatment	Mean No. of Rooted Daughters	Mean No. of Unrooted Daughters
Blossoms Removed	116.00	37.33
Blossoms Remained	120.30	36.33
Statistical Significance	ns	ns
CV%	26.85%	20.01%

10.4 Conclusions

De-blossoming does not appear to positively impact daughter production. Therefore, de-blossoming may not be necessary. Similarly crown sizes ranging from a mean of 0.8 to 1.6 cm in diameter did not influence any of the parameters tested.

11.0 Agrologist Training

A website was developed which contains photographs of planting, harvesting equipment as well as trimming sheds. Our progress and final reports are also accessible through this site. Field days and talks have also provided some information. However, if this industry is to be successful, a coordinated effort between extension, marketing, human resource and research personnel is required.

12.0 Cost of Production Information

Information has been collected throughout the 1998-1999 growing season regarding all potential production costs. The Agriculture Economics Department has compiled information at the University of Saskatchewan and has issued a final report.

13.0 Commercialization

The first commercial strawberry crown venture occurred in 2000. It was a direct result of the research both on the horticultural and economic aspects of northern vigour. Five individuals formed a partnership, and produced strawberry plants on 10 acres in the Pike Lake region south east of Saskatoon. This commercial venture (100% self-funded) permitted identification of key issues critical for further commercialization which would not have otherwise been understood on a research scale. Some of these issues are being addressed through the ADF grant # 20010051 (Northern Vigour of Strawberry Crowns: Addressing Commercial Development Needs). These issues include: 1) Development of nematode testing facilities at the Crop Protection Lab (Regina); 2) Optimize post-harvest storage and handling; 3) Scope out cost of development of parent plant material and micropropagation.

To provide greater awareness of crown production, growers have been contracted to produce strawberry crowns on a small scale for ADF 20010051. In addition, one of our strawberry plots is at the Agri-Arm Spoke site in Rosthern which if expanded to other spoke sites, should be an effective way to demonstrate strawberry crown production.

B) GARLIC (*Allium sativum* L.)

14.0: Storage Period and Seedling Vigour of Garlic

For proper cloving, garlic requires an exposure to an extended period of low temperature prior to commencement of vegetative growth (Bandara et al., Can. J. Plant Sci. 2000). When cloves are seeded in the fall, this requirement is generally fulfilled due to over-wintering. However, considerable crop loss in garlic can occur due to Saskatchewan's harsh winters causing winter-kill. Spring planting is therefore a popular planting practice among garlic growers in the province; however, seed must be stored for use or purchased each spring.

14.1 Objective

The objective of this study is to determine the effect of the storage period on seedling vigour and cloving in garlic under greenhouse conditions.

14. 2 Materials and Methods

Garlic from four local garlic selections (local cultivar No.1 from Larry Balion, Saskatoon SK; local cultivar No. 2 from Al Nyirfa, Wakaw, SK, and local cultivar No.3 and No. 4 from Don Moffat, Tisdale, SK) were used in conjunction with 'California Early' and 'California Late'. Samples consisting of 10 cloves were removed at 6, 10, 14, 18, and 22 weeks after being placed into storage. The garlic cloves were stored in the dark at 2-3°C conditions. Cloves were planted in 4"x 4" pots filled with No. 4 'Sunshine' medium. Pots were placed in 22°C ± 2°C temperatures with 16h days and night temperatures of 16°C ± 2°C. Fertilizers consisted of five hundred ppm (500mg/L) solution of 20:20:20 (N: P: K) at 25 mL/pot weekly. Measurements and observations included plant height and leaf number at 2, 4, 6 and 8 weeks after planting, plant height at harvest and number of cloves/bulb, mean bulb diameter, mean bulb weight and mean clove weight at harvest.

14.3 Results

14.3.1 Plant heights

Each cultivar reacted to the storage conditions differently (Table 14.1). All factors of cultivar, storage and cultivar x storage period were all significant. As expected, plant height generally increased with time of observation after removal from storage from 2 to 8 weeks of height measurements under greenhouse conditions. However, no clear benefit was observed after 10 weeks of storage for any cultivar.

LWG, a local cultivar no.1 from Larry Balion, Saskatoon SK., significantly increased in height at the two week measurement after ten weeks in storage. At the time of the four-week evaluation, a decrease occurred at ten weeks of storage. For weeks six and eight, there were no significant differences in the plant height between the various storage treatments. The decrease that occurred could be caused by disease problems, which occurred at the 10, and 14-week storage periods. Problems were corrected at the 16-week storage period, whereby thereafter, LWG showed no significant differences.

CL (California Late) showed a notable increase in plant height at 2, 4 and 6 week evaluation periods during the 14 weeks in storage point. An increase was also noted after 22 weeks in storage for the 6 week plant height evaluation. At the 8 week measurement, an oscillation occurred in a decreasing, increasing, decreasing fashion in plant heights at 10, 14 and 18 weeks in storage respectively. At 22 weeks in storage no significant difference was noted.

DWG (local cultivar no.3 from Don Moffat, Tisdale, SK.) began with a decrease in height at 18 weeks in storage and a subsequent increase after 22 weeks in storage for the two week plant height evaluation. Heights taken at four and six weeks oscillated in a decreasing, increasing pattern ending in an increase at 22 weeks in storage. Plant heights at week 8 had a significant increase at 18 weeks of storage. DWG had viral and disease problems throughout the duration of the experiment.

CE (California Early) increased in height at the two-week measurement after 10 weeks in storage, however, CE height then declined for the remaining evaluation periods. No significant difference was noted for the weeks four and six plant height measurements, with a decrease occurring after 16 weeks in storage at the eight week measuring interval. Cultivar CE also had disease and viral problems

The final cultivar AWG (local cultivar no. 2 from Al Nyirfa, Wakaw, SK.) had increases in plant height after 10 weeks and 14 weeks in storage for the 2 and 4 week measurement period respectively. At plant heights for weeks 6 and 8, a decrease was noted at 18 and 22 weeks in storage.

When comparing all cultivars at each plant height evaluation, CE and CL had no significant differences for any of the plant height evaluations. For the second week measurement, AWG was larger than the other cultivars. At week 4, only DWG was significantly lower. For weeks six and eight, CL and CE were larger than LWG, AWG and DWG.

14.3.2 Leaf number

Similar to height responses, each cultivar again reacted differently to the storage periods in terms of increasing and decreasing in leaf numbers (Table 14.2). All factors of cultivar, storage and cultivar x storage period were all significant. As expected, leaf numbers continued to increase with weeks of measurement under greenhouse conditions (2-8 weeks of observation after removal from storage). Again, no significant benefit was observed for storage times greater than 10 weeks. Ten weeks appeared to be the optimum storage period.

LWG significantly increased leaf numbers after 10 and 18 weeks in storage at the 2 week observation period. A decrease in leaf number was noted at the 22-week storage point. An increase occurred after 14 weeks in storage at observation weeks four, six and eight. An increase was also noted at 18 weeks in storage during the sixth week response measurement.

CL oscillated in an increasing, decreasing, increasing manner for the two-week measurement. At week 4, a decrease in leaf numbers occurred after 10 weeks in storage. In the 6th and 8th week measurement, fluctuations occurred at 14 and 18 weeks in storage, however, both leaf count intervals had an increase after 8 weeks of growth. DWG fluctuated in an increasing and decreasing fashion for the 4th, 6th and 8th week leaf counts. During the 2nd week leaf count an increase in leaf numbers occurred after 8 weeks in storage. CE also changed as it increased and decreased in leaf numbers for the two-week leaf count and the sixth week measurement. Weeks 4 and 8 had a decrease at 10 weeks and increase at 18 weeks of storage. AWG increased at 10 week for the first count after 2 weeks of growth. At 6 weeks of growth, an increase was seen at 14 weeks which continued to grow significantly to week 22 in storage. At the 8th leaf count interval, an increase was again seen after 14 weeks in storage, however, numbers declined at week 18 with a sharp increase at week 22.

When comparing cultivars, CL and CE had no significant differences in leaf numbers for leaf counts 4, 6 and 8. At each of these measurements, CL and CE were significantly larger than AWG, LWG and DWG. This indicates that these are the more vigourous of the cultivars. Leaf numbers after 22 weeks storage showed to be significantly greater than the 8, 10, 14 and 18 week storage periods.

14.3.3 Bulb Diameter, Bulb and Clove Weight & Number of Cloves

Bulb diameter was significant for cultivar, storage and cultivar x storage time. Bulb weight was significant for storage time and cultivar x storage time. Clove number and clove weight were significant only for cultivar and storage time but there was no interaction effect (Table 14.3).

Problems with *Fusarium* species and with virus caused plant material to die pre-maturely and to not form any bulbs. Instead a green onion like tip was produced and could not be measured. There was much variation in the bulb weight, number of cloves and clove weight data (Table 14.3).

DWG had the largest overall bulb diameter. Garlic stored to 22 weeks had the greatest diameter. Storage periods 14 and 18 weeks were not significantly different and induced the second largest bulb diameter. For the cultivar and storage interaction, LWG, CL and CE had no significant differences for bulb weight. DWG had an increase after 18 weeks in storage, while AWG increased after 22 weeks in storage.

In comparing cultivars against bulb weights, there was no significant difference between the cultivars. However, AWG had the highest mean bulb weight over all storage periods. Fourteen and 22 week storage periods generally induced the greater bulb weights. With respect to cultivar X storage period interaction, only AWG and CL had significant decreases in bulb weight where each expressed a decrease after 18 weeks in storage.

CL had a significantly higher number of cloves per bulb when compared to other cultivars. The remaining cultivars, LWG, AWG, DWG and CE were not significantly different. Bulbs stored for 22 weeks had significantly higher clove numbers. There was no significant difference when the storage and cultivars were analyzed as an interaction.

Significant differences were found between the various cultivars for clove weights. CL had a significantly lower weight than LWG, AWG and DWG. There was no significant difference between CE and CL. A significant decrease in clove weight was observed from 14 to 22 weeks in storage. No significance was noted in a cultivar and storage period interaction.

As an overall comparison of cultivars, DWG had the greatest bulb diameter, however, there was no difference in the bulb weight for DWG or any of the other cultivars. CL had the greatest number of cloves, however the number of cloves sacrificed per clove weight. AWG, DWG and LWG had no significant difference in clove numbers. In terms of storage, 22 weeks in storage produced the greatest bulb diameters and number of cloves. Both the 22 and 14 week storage periods produced the greatest bulb weights, while there were no significant differences in clove weights. When comparing the cultivar, storage interactions, DWG and AWG showed significant increases in bulb diameters after 22 weeks in storage.

CL and AWG significantly decreased in bulb weight after 18 weeks in storage. There were no significant interactions for clove weight and clove numbers.

Table 14.1 Effect of various storage periods on garlic plant height over an 8-week duration (1998).

Location of Origin	Cultivar	Storage Period (weeks)	2 Week Height (cm)	4 Week Height (cm)	6 Week Height (cm)	8 Week Height (cm)
Saskatoon	LWG	8	9.22	39.59	45.78	46.48
	CL		11.37	32.30	47.62	57.32
	DWG		9.90	34.01	33.96	45.88
	CE		4.64	37.36	50.02	57.50
	AWG		13.79	34.54	42.74	46.10
	LWG	10	17.76	28.50	42.03	47.54
	CL		14.10	26.00	42.32	48.98
	DWG		13.86	18.69	22.77	44.50
	CE		21.37	35.02	48.17	56.42
	AWG		19.45	30.18	43.22	48.82
	LWG	14	15.98	34.79	43.10	47.18
	CL		19.19	43.31	48.73	61.86
	DWG		15.51	30.48	37.02	39.26
	CE		15.73	36.49	49.49	56.82
	AWG		20.73	40.96	48.53	51.22
	LWG	18	16.77	35.13	41.61	48.20
	CL		17.61	36.93	45.23	52.52
	DWG		10.11	22.59	25.10	25.94
	CE		19.90	36.60	47.30	49.30
	AWG		17.22	35.49	39.09	43.24
	LWG	22	15.12	32.41	45.90	52.32
	CL		17.06	34.75	51.67	53.86
	DWG		15.22	34.43	45.90	43.30
	CE		14.74	35.38	47.81	53.46
	AWG		18.00	32.10	42.21	39.12
Statistical Significance						
Cultivar			*	*	*	*
Storage Period			*	*	*	*
Cultivar *Storage Period			*	*	*	*
LSD						
Cultivar			2.05	2.78	2.61	3.41
Storage Period			2.05	2.78	2.67	3.41
Cultivar * Storage Period			4.59	6.23	5.97	7.63

Table 14.2 Effect of various storage periods on garlic leaf numbers over an 8-week evaluation period.

Location of Origin	Cultivar	Storage Period (weeks)	Original Clove Weight (g)	Leaf Number 2 weeks	Leaf Number 4 weeks	Leaf Number 6 weeks	Leaf Number 8 weeks
Saskatoon	LWG	8	3.4	1.30	3.58	4.12	4.78
	CL		4.32	1.97	4.21	4.35	5.52
	DWG		4.08	1.55	2.99	3.48	4.79
	CE		3.54	1.38	4.08	4.79	6.17
	AWG		2.62	1.32	3.23	4.17	5.39
	LWG	10	2.82	1.98	3.04	4.00	5.42
	CL		2.96	2.42	3.49	4.58	4.92
	DWG		2.90	1.54	2.43	3.82	5.22
	CE		1.36	2.58	3.86	4.83	5.88
	AWG		3.06	2.23	3.20	4.23	5.17
	LWG	14	2.28	1.82	3.74	5.11	6.33
	CL		1.96	2.29	3.88	1.22	7.20
	DWG		1.88	1.50	3.25	1.25	6.25
	CE		1.36	1.55	3.61	1.65	6.41
	AWG		2.06	2.10	3.75	4.97	6.57
	LWG	18	1.72	2.39	3.74	4.96	6.24
	CL		1.96	2.69	4.02	5.00	6.14
	DWG		1.98	1.49	2.30	4.22	4.68
	CE		2.38	2.99	4.05	5.50	7.22
	AWG		1.66	2.10	3.26	4.58	5.37
	LWG	22	1.92	1.97	3.84	5.64	6.88
	CL		2.40	2.56	4.35	6.97	8.13
	DWG		2.28	2.06	4.18	5.99	6.25
	CE		2.00	2.15	3.96	6.15	7.83
	AWG		2.2	2.00	3.80	6.07	6.55
Statistical Significance							
Cultivar				*	*	*	*
Storage Period				*	*	*	*
Cultivar *Storage Period				*	*	*	*
LSD							
Cultivar				0.22	0.27	0.29	0.39
Storage Period				0.22	0.27	0.29	0.33
Cultivar * Storage Period				0.51	0.60	0.65	0.87

† * denotes significance of $p \leq 0.05$

Table 14. 3 Effect of various storage periods on the garlic bulbs over an 8-week evaluation period.

Location of Origin	Cultivar	Storage Period (weeks)	Bulb Diameter (cm)	Bulb Weight (g)	No. of Cloves	Clove Weight (g)
Saskatoon						
	LWG	14	3.09	13.39	4.00	4.71
	CL		3.64	17.91	6.00	3.07
	DWG		3.31	12.57	4.90	3.31
	CE		3.27	13.65	3.10	5.11
	AWG		3.20	17.59	5.23	4.20
	LWG	18	3.11	12.70	3.40	3.56
	CL		3.56	11.79	5.80	2.07
	DWG		3.70	13.65	3.40	4.14
	CE		3.52	11.42	3.53	4.25
	AWG		2.84	10.59	2.80	3.74
	LWG	22	3.20	12.96	5.87	2.72
	CL		3.42	12.46	2.87	2.58
	DWG		3.77	15.51	5.26	3.55
	CE		3.54	14.96	6.03	2.52
	AWG		3.89	16.33	5.73	3.39
Statistical Significance						
Cultivar			*	ns	*	*
Storage Period			*	*	*	*
Cultivar *Storage Period			*	*	ns	ns
LSD						
Cultivar			0.21	2.13	0.79	0.94
Storage Period			0.21	2.13	0.62	0.94
Cultivar*Storage			0.37	3.69	-	-

† * denotes significance of p≤0.05, ns = not significant

Figure 14. 1 Garlic grown in the Agriculture greenhouses on the University of Saskatchewan campus during the storage study

14.4 Conclusions

Generally, no clear benefit to leaf number or plant height was observed with storage greater than 10 weeks. Cultivars CE and CL had the greatest plant heights and leaf numbers. CL also had the greatest number of cloves, however, they were significantly smaller in comparison to other cultivars. AWG, DWG and LWG tended to have similar results with little to no significant differences between them and the parameters measured. Therefore, adapted CE and CL may be the cultivars of choice to keep in storage since they still grew very well once removed from storage. The trend was for plant material to do better after 22 weeks in storage. There are, however,exceptions to this response and each cultivar will have an optimum storage period. Leaf counts, plant heights, bulb diameters and weights and clove numbers, the 22-week storage period outperformed the shorter storage duration's. The cultivar, storage interaction varied among the various cultivars. CL, DWG, AWG and LWG all had some point in storage where growth and consequentially vigour increased and then decreased.

Optimum duration of storage under cool temperatures are cultivar-dependent but also depend upon which parameters are of most importance to the grower. Vegetative growth (leaf number, plant height) have a shorter storage threshold than parameters of cloving, bulb and clove weight.

15.0 Tissue Culturing of Garlic

15.1 Objectives

Virus in garlic is a problem for California producers. Tissue culturing of garlic is widely used in California to provide disease and virus-free seed. The objective of this study is to provide clean, tissue-cultured plantlets as a comparison to Saskatchewan-adapted and California-grown cloves for subsequent "Northern Vigour" response.

15.2 Materials and Methods

Garlic from four local garlic selections (local cultivar No.1 from Larry Balion, Saskatoon SK; local cultivar No. 2 from Al Nyirfa, Wakaw, SK, and local cultivar No.3 and No. 4 from Don Moffat, Tisdale, SK) were compared within the study.

The protocol followed for meristem culture, was described by Seabrook (1994) and Walkey *et al.*, (1997). Meristem culture was initiated on January 12, 1999 for local cultivar No. 1 and No. 3. Local cultivar No. 2 and cultivars California Early and California Late were initiated on January 13th, 1999. Once initiated, the plant material was cultured utilizing three methods to determine which method would produce cleaner plantlets; meristem (Seabrook, 1994), thermo treatment (Seabrook, 1994) + meristem (Walkey *et al.*, 1997) and block (Seabrook, 1994). Within each method, plantlets in culture were placed in four differing light and temperature regimes; cold (5^0C)& dark, warm (24^0C) & dark and warm (24^0C) & light (16 hr. days at <40µm mol. m^{-2} s^{-1}). All treatments were placed on G8 bulbing media in magenta boxes to induce the formation of garlic bulbs. The magenta boxes contained approximately six garlic plantlets each. Each treatment was had either some (<6 multiplied), all or no multiplication occur) (Table 15.1). Cultures placed in warm, light conditions seemed to have had the greatest success in multiplication, since all or some of the cultivars reacted favorably to the conditions. All treatments were then moved to light conditions and remained in culture until all treatments had recovered. The treatments were then moved into the greenhouse for further testing. Garlic produced by tissue culture were compared with those produced in the field, under greenhouse conditions, to assess the potential impact of virus on bulb yield of garlic.

15.3 Results

All treatment methods induced rooting in all cultivars (Table 15.1). Bulbing was dependent upon exposure to warm temperatures but was not dependent upon light in all cultivars. Either light or dark conditions induced bulbing. This was consistent for meristem, block and thermotreatment methods. Multiplication was difficult to obtain in culture. Thermotreatment provided the best results under either warm + light (AWG, LWG, DWG) or warm + dark (CE). However, thermotreatment was the most difficult method to obtain cultures of all cultivars. Between cultivars, CL and CE most easily multiplied in culture.

Table 15. 1 The effect of various temperatures and light regimes on rooting, bulbing and multiplication.

Culture Method	CV	Temp. Regime	Temp. °C	# Boxes	# Plantlets	Roots	Bulbing	Multiplication
Meristem	AWG	Cold & Dark	5°C	2	12	Yes	No	None
		Warm & Dark	24°C	2	12	Yes	Some	None
		Warm & Light	24°C	2	12	Yes	Yes	Some
	LWG	Cold & Dark	5°C	1	6	Yes	No	None
		Warm & Dark	24°C	1	6	Yes	Yes	None
		Warm & Light	24°C	1	6	Yes	Yes	None
	DWG	Cold & Dark	5°C	1	6	Yes	No	None
		Warm & Dark	24°C	1	6	Yes	Yes	Some
		Warm & Light	24°C	1	6	Yes	Yes	No
	CL	Cold & Dark	5°C	2	12	Yes	No	None
		Warm & Dark	24°C	2	14	Yes	Yes	Some
		Warm & Light	24°C	2	13	Yes	Yes	Some
	CE	Cold & Dark	5°C	2	12	Yes	No	Some
		Warm & Dark	24°C	1	6	Yes	Yes	Some
		Warm & Light	24°C	2	12	Yes	Yes	Some
Block	AWG	Cold & Dark	5°C	None*				
		Warm & Dark	24°C	None				
		Warm & Light	24°C	None				
	LWG	Cold & Dark	5°C	2	13	Yes	No	None
		Warm & Dark	24°C	3	12	Yes	Yes	Some
		Warm & Light	24°C	2	16	Yes	Yes	Some
	DWG	Cold & Dark	5°C	1	6	Yes	No	None
		Warm & Dark	24°C	1	6	Yes	Yes	Some
		Warm & Light	24°C	1	6	Yes	Yes	No
	CL	Cold & Dark	5°C	3	18	Yes	No	None
		Warm & Dark	24°C	2	13	Yes	Yes	Some
		Warm & Light	24°C	3	18	Yes	Yes	No
Thermo-Treatment	AWG	Cold & Dark	5°C	1	6	Yes	No	No
		Warm & Dark	24°C	1	6	Yes	Yes	No
		Warm & Light	24°C	2	13	Yes	Yes	All
	LWG	Cold & Dark	5°C	None				
		Warm & Dark	24°C	None				
		Warm & Light	24°C	1	6	Yes	Yes	All
	CL	Cold & Dark	5°C	None				
		Warm & Dark	24°C	None				
		Warm & Light	24°C	None				
	CE	Cold & Dark	5°C	2	12	Yes	No	None
		Warm & Dark	24°C	3	19	Yes	Yes	All
		Warm & Light	24°C	2	12	Yes	Yes	None
	DWG	Cold & Dark	5°C	1	6	Yes	No	None
		Warm & Dark	24°C	1	6	Yes	Yes	None
		Warm & Light	24°C	1	6	Yes	Yes	All

* Loss due to contamination or failure to survive treatment.

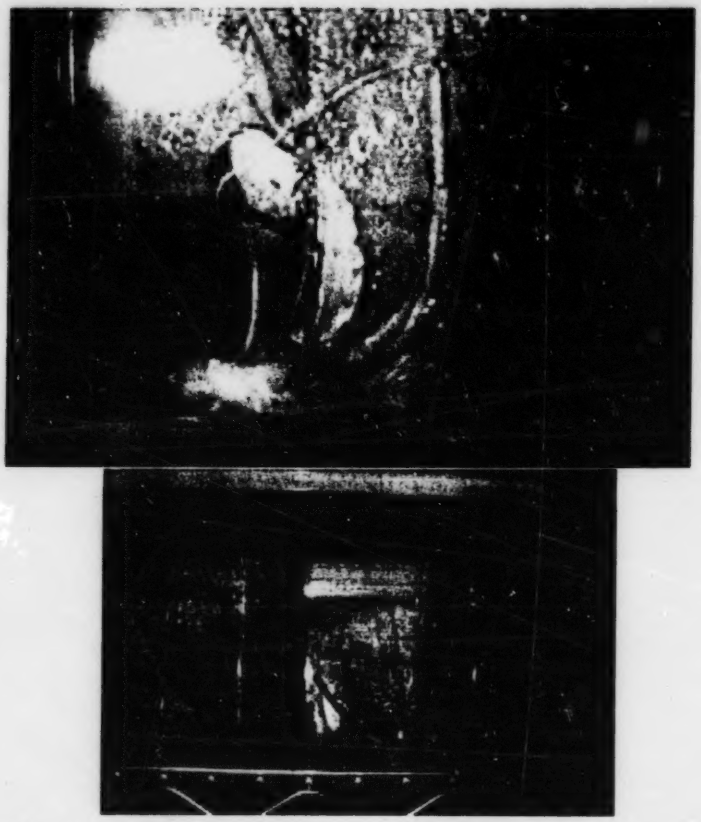


Figure 15. 1 Tissue cultured garlic within magenta boxes in growth chamber, 2001.

15.4 Conclusions

Rooting was easy to induce in all cultivars under all treatments. Bulbing was also easily induced but not under low temperature conditions. Only the thermo-treatment most successfully multiplied the plantlets mainly under warm and light conditions, however, this treatment also was the most difficult to get plantlets into culture. CE and CL were multiplied in culture more easily under more treatments compared to the other cultivars. Thermotreatment appears to be the best all-round technique for certain cultivars.

16.0 Medicinal Evaluation of Garlic for Alliin and Allicin

In garlic, the medicinal market appears to be more lucrative than the extraction of essential oils for culinary purposes (Lokken et al., 1998 ADF final report). The world value of medicinal garlic is well over $ 1billion U.S. with potential replacement value significantly more. Alliinn and allicin are considered to represent medicinal components of garlic. Extractions of alliin and allicin were performed from existing samples in storage to determine if Saskatchewan has a superior medicinal activity in its product.

Allicin and alliin are sulfur compounds found in garlic. Alliin is the major flavor precursor of garlic (Verlag, 1995). Through an enzymatic reaction, allinase converts alliin into allicin which is the odoriferous substance of garlic (Block, 1985). Allicin is believed to help the body fight off infections and bacteria by enhancing the immune system, lowering of blood pressure and reducing cholesterol (SAF, 1994). Extensive medical research is currently conducted to determine the effectiveness of garlic in prevention of various forms of cancer.

16.1 Objectives

In garlic, the medicinal market appears to be more lucrative than the extraction of essential oils for culinary purposes. For this reason, extractions were conducted from existing samples in storage to determine if Saskatchewan has a superior medicinal quality in its product.

16.2 Materials and Methods

Samples of 'California Early', 'California Late' and four local garlic selections (local cultivar No.1 from Larry Balion, Saskatoon SK; local cultivar No. 2 from Al Nyirfa, Wakaw, SK, and local cultivar No.3 and No. 4 from Don Moffat, Tisdale, SK.) were collected in the fall of 1998 and shipped to Empire Farms in Nevada where allicin and alliin extraction of the samples will occur. Due to shipping difficulties, samples stored at –80°C were not shipped in November of 1998. However, fresh samples were shipped to Empire Farms at UC Davis in the fall of 1999. In the fall of 1999, samples consisted of local garlic selections (local cultivar No.1 from Larry Balion, Saskatoon SK; local cultivar No.3 Don Moffat, Tisdale, SK., and garlic from – M&M Farms (Dave and Krista McBain, Whitefox, Saskatchewan) and Getz's garlic (Graham Getz, Birch Hills SK.). These plus samples of California Early (CE) and California Late (CL) grown in Saskatoon were shipped to Empire Farms in Davis, California (Tom Ikesaki and Missy Naguwa) and to PureGar in Chatsworth, CA for the extraction of allicin and alliin.

In 2000, Samples consisting of local garlic selections (local cultivar No.1 from Larry Balion, Saskatoon SK; local cultivar No.3 Don Moffat, Tisdale, SK., and garlic from – M&M Farms (Dave and Krista McBain, Whitefox, Saskatchewan) were collected in the fall of 2000. These, plus samples of California Early (CE) and California Late (CL) grown in Saskatoon, were shipped to Empire Farms in Davis, California (Tom Ikesaki and Missy Naguwa) for the extraction of allicin and alliin. Each sample was replicated for statistical analysis.

16.3 Results

In 1999, alliin levels were highest in the garlic line LWG (Table 16.1). Getz garlic and California Early (CE) grown in the USA had the lowest alliin levels in that year of production. Saskatchewan-grown CE had 42% higher alliin levels compared to the California-grown bulbs. By contrast, there was no major difference in alliin content of CL bulbs when grown in either California or Saskatchewan. Allicin levels are highest in CE from the USA, even though alliin (the precursor to allicin) was one of the lowest levels according to the Empire data. Allicin from Saskatchewan-grown CE bulbs was 22% lower than its California-grown counterpart. By contrast, Saskatchewan-grown CL was 10% higher than its California –grown bulbs. LWG and M&M garlic have levels of allicin and only slightly lower than CE – USA. Method of extraction/analysis impacts the levels of allicin extracted where depending upon whether the same sourced bulbs were processed at Empire or PureGar, results were widely different. These allicin levels varied for every cultivar tested and ranged from 3% - 72% depending upon whether Empire or PureGar processed the samples. PureGar results indicate CE grown in Saskatchewan has the highest allicin levels followed by DWG.

Table 16. 1 Alliin and Allicin levels in Saskatchewan and USA sourced garlic lines in 1999.

Garlic Line	Empire – Alliin (ppm)	Empire – Allicin (ppm)	PureGar – Allicin (ppm)
DWG	7773	3200	4150
LWG	9549	4300	2500
AWG	7542	3900	3000
CL – grown in SK.	7580	3300	3200
CE – grown in SK.	7831	3600	4300
Getz	6728	3300	
M&M	7159	4200	
CE-USA grown	5500	4400	
CL-USA grown	7600	3000	

In 2000, alliin levels were much higher in all samples evaluated at Empire Farms compared to the previous year (Tables 16.1, 16.2). Cultivar was significant for both alliin and allicin response measurements (Table 16.2). The US-grown CE line from Christopher Ranch was significantly higher than either the Saskatchewan-grown CE or CE originating from the La Ronge and Saskatoon locations. Similarly, allicin from California-sourced bulbs was also significantly greater than the Saskatchewan counterpart. Notably, when the CE bulbs which had become adapted to Saskatchewan conditions over a period of several years were then grown in the U.S. at Christopher Ranch, those alliin and allicin levels were significantly lower than either the CE grown in Saskatchewan or that which was continuously grown in California (Table 16.2).

Table 16.2 Comparison of allicin and alliin levels (ppm) extracted from California Early garlic grown in La Ronge, Saskatoon and Christopher Ranch (USA and Saskatchewan sample) 2000-2001.

Garlic Line	Alliin (ppm)	Allicin (ppm)
CE-Christopher Ranch (USA Sample)	14100	5000
CE-La Ronge, SK.	9967	3433
CE-Saskatoon, SK.	10633	3467
CE-Christopher Ranch from SK.	7867	2633
Statistical Significance		
Cultivar	**	**
LSD	2538	1238

† ** denotes $p \leq 0.01$

As previously observed in Table 16.2, over time, CE became adapted to Saskatchewan conditions. When these bulbs were subsequently sent and grown in California and compared to CE continuously grown in California, the alliin and allicin levels of Saskatchewan-adapted bulbs was expectedly lower (Table 16.3). None of the Saskatchewan-adapted cultivars when grown in the U.S. and then extracted and analyzed for alliin and allicin content could surpass the CE-cultivar which was already adapted to California conditions. The Chinese cultivar which was grown in Saskatchewan for 2 years ranked 5th out of 9 cultivars for alliin and allicin content.

Table 16. 3 Allicin and alliin levels (ppm) of the garlic lines grown at Christopher Ranch only, 2000-2001.

Garlic Line	Alliin (ppm)	Allicin (ppm)
California Early from USA only	14100	5000
California Early Stiff Neck	9067	3233
California Late	10033	3033
Chinese Cultivar #1	11367	3333
California Late Stiff Neck	13200	3900
California Early from SK.	7867	1733
LWG	9700	2800
DWG	13233	3867
M&M	12067	3587
Statistical Significance		
Cultivar	**	ns
LSD	2218	-

† ** denotes $p \leq 0.01$, ns = not significant

When garlic adapted to Saskatchewan conditions was grown in Saskatchewan, both alliin and allicin levels were considerably higher than SK-adapted garlic grown in California (Table 16.4). Compare 7867 ppm alliin of CE (Table 16.3) to 10,633 ppm alliin of CE when the same garlic is grown in Saskatchewan (Table 16.4). Similarly, compare 1733 ppm allicin of CE (Table 16.3) to 3467 ppm allicin (Table 16.4). Cultivar was highly significant. Chinese garlic grown in Saskatchewan expressed the highest alliin and allicin content of any garlic tested with Chinese cultivar #2 expressing 12.8 and 16.0% higher alliin and allicin, respectively compared to the CE grown in the U.S.A.

Garlic grown in La Ronge did not perform well with alliin and allicin generally below levels of bulbs grown in other locations (Tables 16.5, 16.6).

Table 16.4 Allicin and alliin levels (ppm) of the garlic lines grown at Saskatoon, 2000-2001.

Garlic Line	Alliin	Allicin
California Early from USA only	14100	5000
California Early from SK.	10633	3467
California Late	13633	4633
California Late Stiff Neck	14633	4467
Chinese Cultivar #2	15917	5800
LWG	13350	4567
AWG	13067	1267
DWG Stiff Neck	11800	3933
Chinese Cultivar #1	15133	4867
Chinese Cultivar #4	15400	5667
Statistical Significance		
Cultivar	**	**
LSD	2094	1094

† ** denotes p≤0.01

Table 16. 5 Allicin and alliin levels (ppm) of the garlic lines grown at La Ronge only.

Garlic Line	Alliin	Allicin
California Late Stiff Neck	7900	2333
California Early from SK.	9067	3433
DWG Stiff Neck	5467	1733
DWG	11000	3800
California Late	9967	2500
LWG	6967	3333
Statistical Significance		
Cultivar	**	**
LSD	3756	1025

† ** denotes p≤0.01

While location or garlic line itself were not significant, the interaction was highly significant (Table 16.6). In terms of allicin content, the top location x cultivars were: CE grown in California, Saskatoon-grown CL, CL-stiff neck and LWG. Thus, Saskatchewan has potential to be competitive with U.S.-grown cultivars if those cultivars are adapted to Saskatchewan-growing conditions and are grown in-province.

Table 16. 6 Allicin and alliin levels (ppm) of the all the garlic lines evaluated at Empire Farms.

Location Garlic Grown	Garlic Line	Alliin (ppm)	Allicin (ppm)
La Ronge	*California Early from SK.*	9967	3433
	California Late	7900	2500
	DWG	11000	3800
	LWG	9400	3333
	California Late Stiff Neck	6967	2333
Saskatoon	*California Early from SK.*	10633	3467
	California Late	13633	4633
	DWG	11800	3933
	LWG	13350	4567
	AWG	13067	1267
	California Late Stiff Neck	14633	4467
Christopher Ranch	*California Early from U.S.*	14100	5000
	California Early from SK.	7867	2633
	California Late	10033	3033
	DWG	13233	3867
	LWG	9700	2800
	California Late Stiff Neck	13200	3900
Statistical Significance			
Location		ns	ns
Garlic Line		ns	ns
Location*Garlic Line		**	**
LSD			
Location*Garlic Line		2320	610

† ** denotes $p \leq 0.01$, ns = not significant

16.4 Conclusions

Saskatchewan has potential to be competitive with U.S.-grown cultivars if those cultivars are adapted to Saskatchewan-growing conditions and are grown in-province. Chinese cultivars expressed high levels of both alliin and allicin. High alliin levels did not correspond with high allicin levels. Therefore, the allinase activity should be tested in future.

17.0 Yield and Yield Components of Saskatchewan-grown garlic tested in California

17.1 Objectives

The objective of this study is to examine the effect of latitude of garlic bulb origin on bulb yield, bulb height, bulb diameter and number of cloves per bulb.

17.2 Materials and Methods

Original planting material for the study was propagated at three sites in Saskatchewan (local cultivar No. 1 (LWG)(52.°10'N) and local cultivar No. 3 and No. 4 from (DWG) (52 °.51'N). Two US garlic cultivars, California Early (CE) and California Late (CL) were also included. Garlic planted in the fall of 1997 (local cultivar No.1 from Larry Balion, Saskatoon SK; local cultivar No. 2 from Al Nyirfa, Wakaw, SK, and local cultivar No.3 and No. 4 from Don Moffat, Tisdale, SK.) was harvested in the summer of 1998. Samples of these four local cultivars were shipped to Empire Farms in Nevada, USA on October 15th, 1998 where further testing occurred.

These garlic cultivars which were previously propagated from four sites (Saskatoon, La Ronge, Tisdale and Wakaw) were spring-planted at three sites in 1998 – Saskatoon, Wakaw and La Ronge – on May 8th, 15th and 26th respectively. Garlic was planted at a spacing of 10cm within row and 50cm between rows. Standard cultural practices for the region were adopted. Based upon the crop maturity, garlic was harvested in Wakaw on September 2nd and 9th, in Saskatoon on September 1st and 9th and in La Ronge on September 4th and 7th, 1998. Garlic was cured for two weeks at room temperature conditions (22±2°C). Measurements included plot yield, mean bulb weight, bulb diameter and height and number of cloves per bulb.

On October 28th, 1998 garlic was planted at the Horticulture Research Plots at the University of Saskatchewan. These included cultivars No.1 from Larry Balion, Saskatoon SK (LWG); local cultivar No. 2 from Al Nyirfa, Wakaw, SK (AWG), and local cultivar No.3 from Don Moffat, Tisdale, SK. (DWG) and California Early and California Late was harvested in the summer of 1999. Samples consisting of 5lbs of each local cultivars were shipped to Empire Farms in Nevada, USA on October 26th, 1999 where further testing will occur. Garlic was also purchased from two local producers – M&M Farms (Dave and Krista McBain, Whitefox, Saskatchewan) and Getz's Garlic (Graham Getz of Birch Hills, Saskatchewan). Data was also collected on these two lines. Response measurements included total cultivar yields, bulb diameter, bulb width and clove numbers per bulb. This garlic was harvested in the fall of 1999 and shipped to Thomson International for further trials. A larger sample of M&M, Getz and local cultivar No. 1 totalling 61 kg was sent to Bill Christopher of Christopher Ranch in Gilroy, California in 1999. The garlic was planted out and data was collected regarding total cultivar yields, bulb diameter, bulb width and clove numbers per bulb.

The garlic sent to Christopher Ranch was planted in two trials both on the west side of the San Joaquin Valley about 1 hour west of Fresno, California. The first plot was situated more precisely 3 miles east of Interstate 5 and Panoche RD in Fresno County, CA and the second plot was west of Five Points, CA. (Figs. 17.1-17.8). Photos taken are courtesy of Mike Mantelli who manages the seed and commercially grown garlic for Christopher Ranch. Updates were provided monthly by Mike to show the progression of the field trials.

Five Points, CA Plot

The plots at Five Points were planted on November 11th, 1999. The planting rate was 6.5 cloves per foot. It was hand planted and watered with first sprinkler irrigation then furrow. Applications of fertilizers and herbicides have been consistent throughout the field. The prior crop was cotton.

Fresno County, CA Plot

This location was hand planted and watered with first sprinkler irrigation then furrow. Applications of fertilizers and herbicides were consistent through out the field. The prior crop was tomato.

17.3 Results

Due to poor crop performance, the garlic plots at the Wakaw site were abandoned. Unfortunately, garlic shipped to Thomson International and Empire Farms (Empire, NV) in the fall of 1998 did not result in any data received. Similarly, garlic shipped to Empire farms (Empire, NV) in the fall of 1999 did not result in any results. Changes in personnel may have caused the problem. However, Christopher Ranch supplied both data and photos of the garlic plots.

The M&M garlic sized well in comparison to the other lines at both California locations (Figs. 17.1, 17.3, 17.6, 17.7). The bulbs were a minimum of 6.35cm in diameter. During the storage period, however, this garlic line lost a considerable amount of weight from the time of harvest until November. When harvested, the M&M garlic weighed 78kg. In September the weight dropped to 71kg and further to 59 kg by November 15th, 2000. The internal tissues of the bulbs started to break down considerably within the last few weeks of storage with germination starting at the top of the bulbs. LWG produced considerably smaller bulbs. Initial weight was 154 kg of material, and by the 15th of November 2000 the bulbs only dropped to 150kg. This garlic line was considered undesirable, since it is too small for any market within California. Getz garlic was also considered to be small and showed many of the same characteristics as LWG. However, the Getz garlic weight during the storage period only dropped slightly from 65 kg to 62 kg in mid November. Both the LWG and Getz showed signs of germination and the bulb size was no greater than 3.81cm.

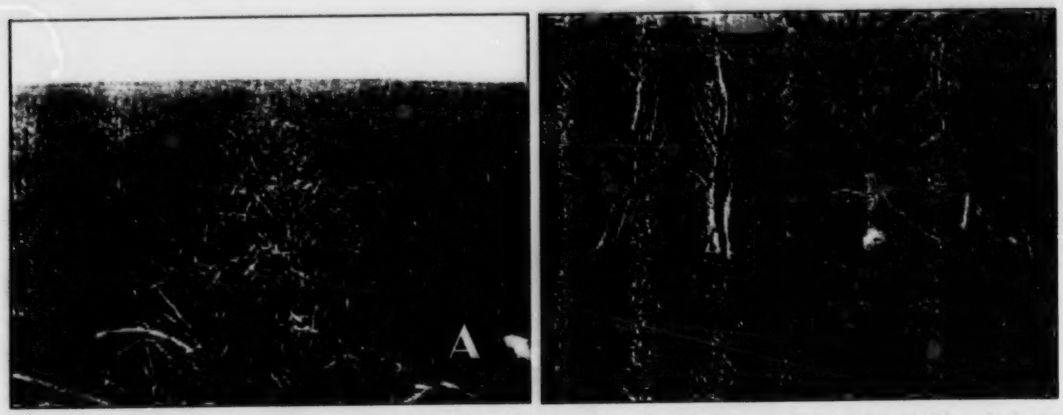


Figure 17. 1 M&M garlic (A) in the field at Five Points, CA. Garlic lines (left to right) California Late, LWG, M&M and Getz garlic in the Five Points field plot in late March 2000.

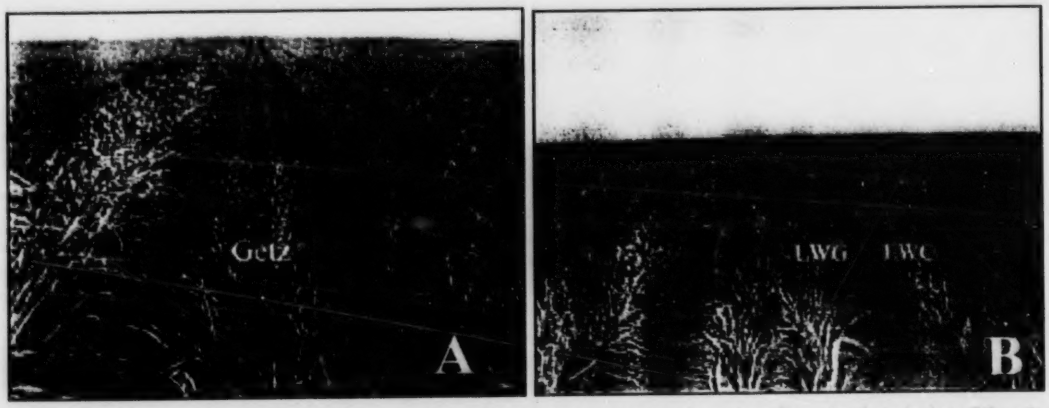


Figure 17. 2 Getz (A) and LWG (B) garlic at Five Points, CA Christopher Ranch plots in late March, 2000.

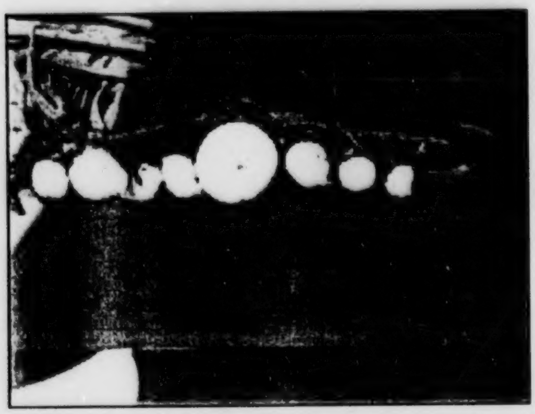


Figure 17. 3 From left to right with two samples of each - California Late, LWG, M&M and Getz garlic, March 2000.

Fresno County, CA Plot

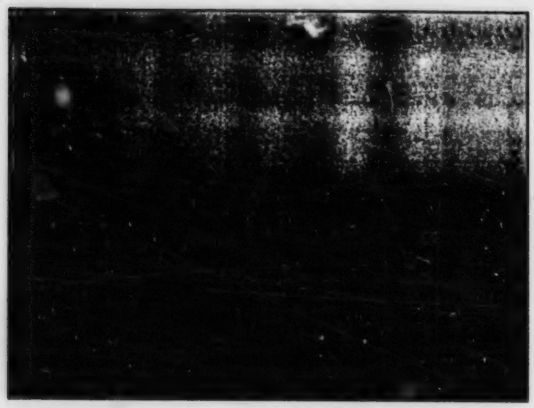


Figure 17. 4 Trials were planted in four rows with blue flags starting and stopping the trials.

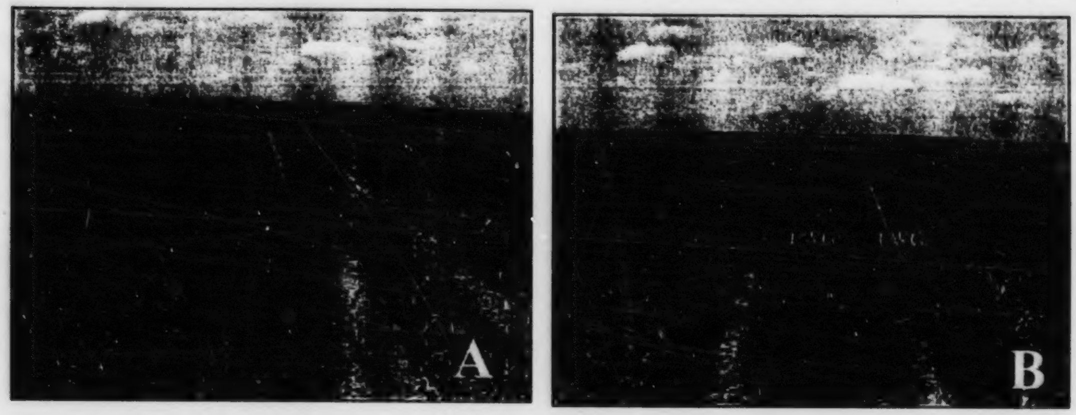


Figure 17. 5 Getz (A) and LWG (B) garlic in Fresno County.

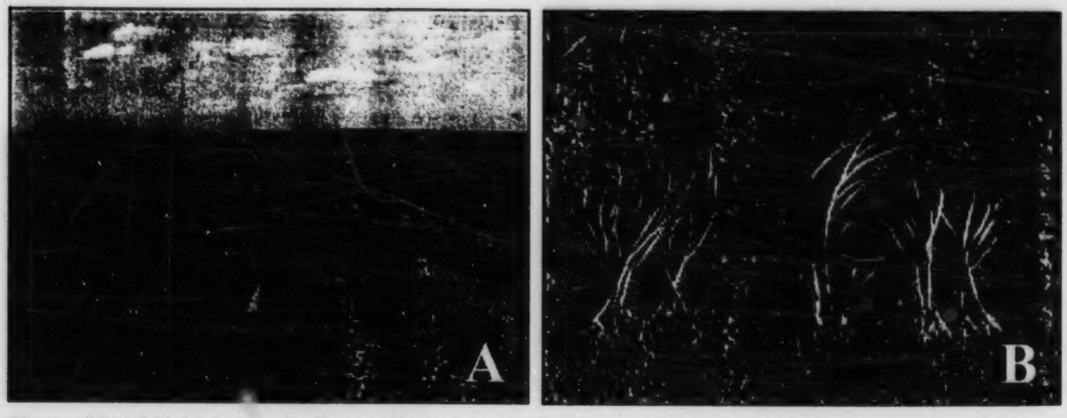


Figure 17. 6 M&M (A) in the Fresno field plot. Garlic removed from the field (B) starting from left to right - LWG, M&M and Getz.

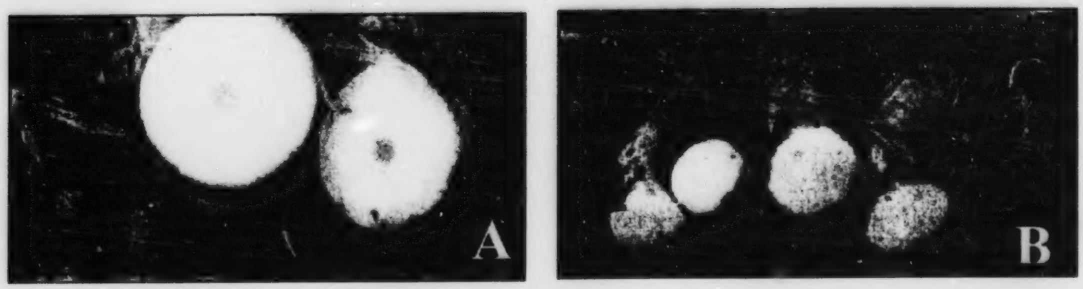


Figure 17. 7 Cross section of M&M garlic (A) and Getz (B).

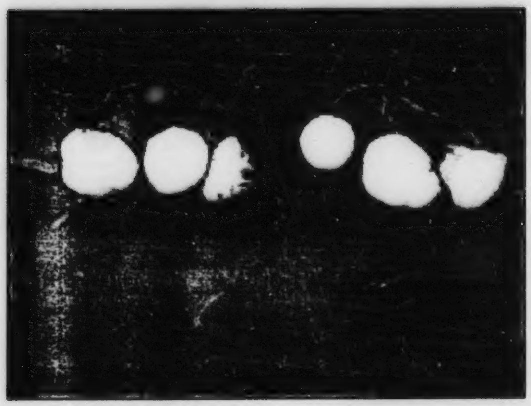


Figure 17. 8 Cross section of LWG garlic showing clove formation.

Cultivar was highly significant (Table 17.1). In the 2001 California production year, bulb weight and diameter of M&M garlic sourced from White Fox, SK was significantly greater than all other garlic lines and locations tested. This was followed by CL-stiff neck grown in Saskatchewan. Clove number was highest in the Chinese Garlic cultivar #1 with an average 8.2 cloves per bulb There was no significant difference in bulb height among cultivars or locations. CE grown in California out-performed the CE grown in Saskatchewan for parameters of bulb weight, height and bulb diameter (Tables 17.1 and 17.2). No significant difference was detected for clove number.

Table 17. 1 Comparison of bulb weight (g), bulb diameter and height (cm) and number of cloves per bulb between garlic lines grown at Christopher Ranch, 2001.

Garlic Line	Bulb Weight (g)	Bulb Diameter (cm)	Bulb Height (cm)	Number of Cloves per Bulb
California Early Stiff Neck, SK.	31.4	4.4	2.7	3.7
California Early, SK.	16.9	3.5	2.4	5.4
California Early USA	34.6	4.6	2.6	7.5
M&M, SK.	79.8	6.4	4.0	6.7
LWG, SK.	19.9	3.9	2.7	7.3
California Late, SK.	16.2	3.6	4.9	4.7
California Late Stiff Neck, SK.	50.9	5.1	3.3	6.8
DWG, SK.	26.3	4.1	2.9	6.8
Chinese Garlic Cultivar #1, SK.	38.8	4.9	3.1	8.2
Statistical Significance				
Cultivar	**	**	ns	**
LSD	15.91	0.91	-	2.91

† ** denotes $p \leq 0.01$, ns = not significant

Table 17. 2 Comparison of bulb weight (g), bulb diameter and height (cm) and number of cloves per bulb between California Early grown in Saskatchewan in season one to California Early grown in the USA season one.

Garlic Line	Bulb Weight (g)	Bulb Diameter (cm)	Bulb Height (cm)	Number of Cloves per Bulb
California Early, SK.	16.9	3.5	2.4	5.4
California Early USA	31.6	4.5	2.6	7.5
Statistical Significance				
Cultivar	*	*	**	ns
LSD	13.2	0.9	0.12	-

† * ** denotes $p \leq 0.05$ and $p \leq 0.01$ respectively, ns = not significant

By the end of the 3rd year, CE had adapted to Saskatchewan-growing conditions and there was no significant difference in bulb weight, diameter or number of cloves per bulb (Table 17.3). Bulb height was significant greater in Saskatchewan-grown plants.

Table 17.3 Comparison of bulb weight (g), bulb diameter and height (cm) and number of cloves per bulb between California Early continuously grown in Saskatchewan in year 3 to California Early grown in the USA only 2000-2001.

Garlic Line	Bulb Weight (g)	Bulb Diameter (cm)	Bulb Height (cm)	Number of Cloves per Bulb
California Early USA	35.6	4.6	2.7	7.5
California Early La Ronge, SK	37.8	4.6	3.7	6.8
California Early Saskatoon, SK	32.6	4.5	3.5	7.4
Statistical Significance				
Cultivar	ns	ns	**	ns
LSD			0.45	

† * ** denotes $p \leq 0.01$, ns = not significant

17.4 Conclusions

A significant cultivar-dependent response was determined on SK-sourced bulbs subsequently grown in California. While no "northern vigour" response was observed on the same cultivar, certain cultivars originating in Saskatchewan (e.g. M&M Garlic) and grown in the U.S. out-performed the U.S.-adapted cultivars. Conversely, U.S.-adapted cultivars did not perform well under Saskatchewan conditions in year one but became adapted after 3 years of continuous growth in Saskatchewan.

18.0 Garlic Yield and Yield Components based on location within Saskatchewan

18.1 Objectives

Garlic was evaluated for cultivar differences when grown under Saskatchewan conditions. Response variables included bulb diameter, height and weight, clove weight and number per bulb. Garlic was both spring and fall planted. Differences between years was also evaluated.

18.2 Materials and Methods

18.2.1 Spring planting, 1998

Seven cultivars were planted on the 31st of May and the 1st of June, 1998 in Saskatoon and La Ronge respectively. Soil analysis was performed by Enviro-Test Laboratories – Plains Innovative Laboratory Services. Fertilizing consisted of a split application of 1/3 of nitrogen to be applied at time of planting, with the other 2/3 applied at time of cloving. Irrigation occurred as was deemed necessary. Garlic was harvested on September 2nd in Saskatoon. Garlic was not harvested in La Ronge due to problems with the plots maintenance. Garlic was purchased from two farms within the province, Getz Garlic (Graham Getz of Birch Hills, SK) and M&M Farms (Dave & Krista McBain, Whitefox, SK.). Data consisted of bulb diameter, height, number of cloves per bulb and their individual clove weights.

18.2.2 Fall planting, 1999

Garlic for evaluation was planted on October 22nd , 1999 in La Ronge and later covered with rice hull mulch to a depth of 6-8 inches. Three local garlic selections cultivars (No.1 from Larry Balion, Saskatoon SK (LWG); local cultivar No. 2 from Al Nyirfa, Wakaw, SK (AWG), and local cultivar No.3 from Don Moffat, Tisdale, SK (DWG) will be compared within the study along with California Early and California Late cultivars. In addition, four Chinese garlic varieties were received from the Qiuzhu Li Changchun City Agriculture School in Jilin China to include in our varietal study. The Chinese varieties were: *Purple Skinned Garlic with only on Clove,* Jilin Province*; Purple Skinned Garlic with four to six cloves,* Jilin Province*; Large Red Robe,* Shang Dong Province *and Purple Skinned Garlic with only one clove in early spring from* Shang Dong Province. Data was collected in the fall of 2000 regarding bulb diameter, bulb height and weight, number of cloves per bulb and clove weight.

18.3 Results

18.3.1 Spring planting, Saskatoon 1998

Results at the Saskatoon site (52'10°N) indicated that on average, garlic originating from Saskatoon produced larger bulbs in diameter than those originating from La Ronge, Tisdale, or Wakaw (Table 18.1). Regardless of location of origin, the garlic cultivar DWG produced significantly larger diameter bulbs, heights and number of cloves per bulb than CL and LWG. On average, Saskatoon-sourced garlic produced higher number of cloves/bulbs than those originating from La Ronge, Tisdale or Wakaw.

On average, location of origin had a significant effect on mean bulb weight of garlic when grown in Saskatoon (Fig. 18.2). Saskatoon-sourced bulbs had both higher bulb weight (Fig. 18.2) and yield (Fig. 18.1) compared to other sources of origin within the province. AWG produced the highest yield than other cultivars tested (Fig. 18.1). Despite the similarities in bulb weight (Fig. 18.2), AWG produced almost a 2-fold increase in yield over that of LWG (Fig. 18.1).

18.3.2 Spring planting, La Ronge 1998

Location of origin was significant for bulb diameter and height but not clove number per bulb (Table 18.2). When sourced from La Ronge and planted in La Ronge, these 2 parameters had the highest values. Cultivar x location effect was also significant and DWG had higher bulb diameter and height when grown from La Ronge-sourced material but this was not consistent with the LWG response. However generally, response was improved when grown sourced from the same location as production. AWG expressed the highest yield and bulb weight when sourced from La Ronge compared to other locations of origin (Figs. 18.3, 18.4).

Table 18. 1 Effect of cultivar and location of origin, on bulb diameter, bulb height and clove number per bulb of garlic grown in Saskatoon, Saskatchewan, 1998.

Location of Origin	Cultivar	Bulb Diameter (mm)	Bulb Height (mm)	No. of Cloves / Bulb
Saskatoon	Cali. Late	37.2	27.6	5.1
	LWG	43.6	32.0	7.9
	DWG	44.9	31.2	9.0
	Mean	41.9	30.1	9.0
La Ronge	Cali. Late	31.9	28.5	3.8
	LWG	37.1	29.1	6.7
	DWG	44.7	35.2	6.9
	Mean	37.9	30.9	5.8
Tisdale	Cali Late	22.4	26.2	2.1
	LWG	38.5	33.5	3.0
	DWG	39.2	33.1	4.6
	Mean	33.4	30.9	4.2
Wakaw	Cali. Late	33.4	27.7	3.5
	LWG	36.3	27.3	7.1
	DWG	35.1	31.2	7.3
	Mean	34.9	28.7	6.0
		Mean Bulb Diameter	**Mean Bulb Height**	**Mean # of Cloves/Bulb**
	Cali. Late	34.5	26.7	4.0
	LWG	33.5	28.2	5.0
	DWG	41.0	33.0	4.2
Statistical Significance				
Cultivar (A)		*	*	*
Location (B)		*	ns	*
AxB Interaction		*	*	ns
LSD				
Cultivar		2.9	1.7	0.77
Location of Origin		3.3	-	0.89
CV & Location		5.7	3.31	-

† * denotes significance of $p \leq 0.05$, ns = not significant

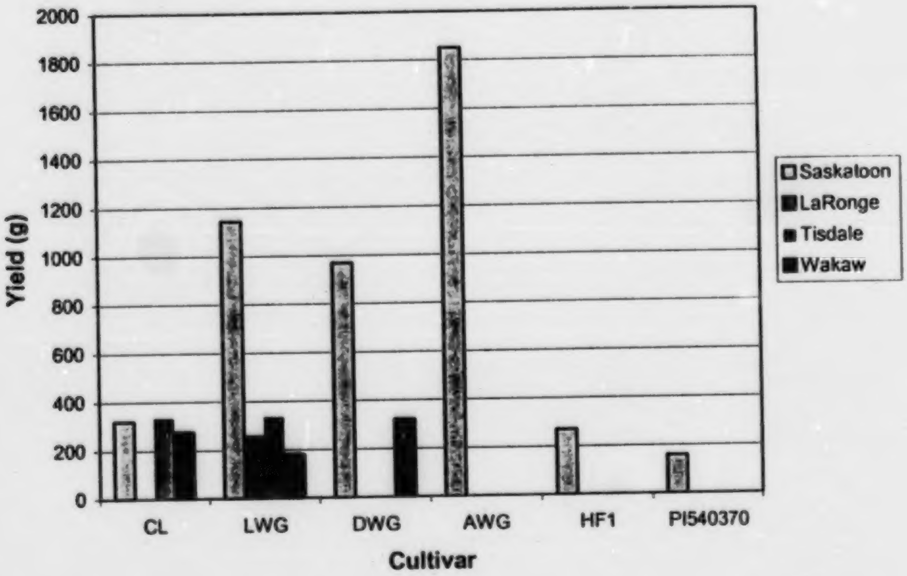


Figure 18. 1 The total yield of garlic grown in Saskatoon, SK, 1998.

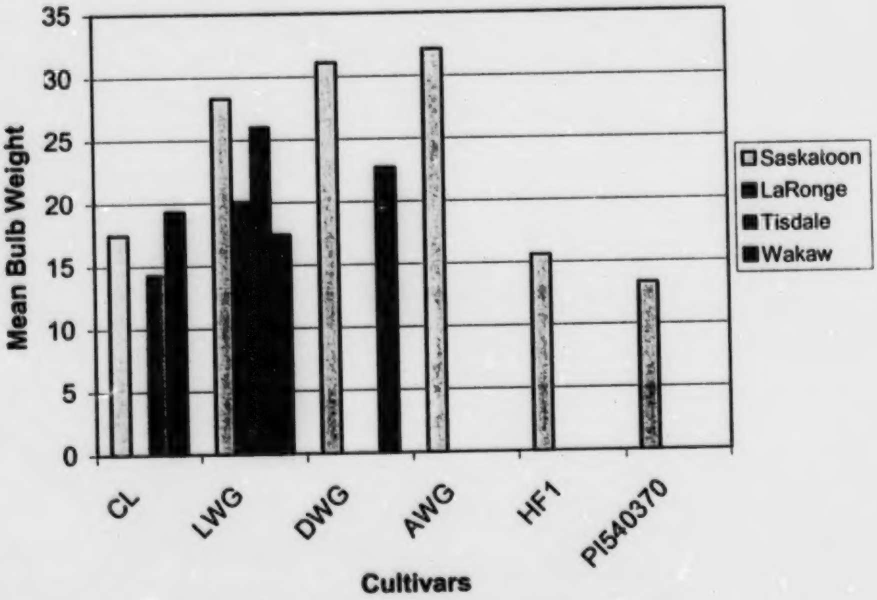


Figure 18. 2 The mean bulb weight of garlic grown in Saskatoon, SK., 1998.

Table 18. 2 Effect of cultivar and location of origin on bulb diameter, bulb height and clove number of garlic grown in La Ronge, Saskatchewan, 1998.

Location of Origin	Cultivar	Bulb Diameter (mm)	Bulb Height (mm)	Number of Cloves / Bulb
Saskatoon	Cali. Late	30.5	24.9	3.2
	LWG	32.6	27.9	4.1
	DWG	37.7	30.0	4.4
	mean	33.6	27.6	3.9
La Ronge	Cali. Late	41.6	30.8	4.8
	LWG	28.1	23.8	4.9
	DWG	51.7	40.0	4.2
	mean	40.5	31.5	4.6
Tisdale	Cali. Late	31.8	24.4	3.9
	LWG	39.8	32.8	6.0
	DWG	33.5	28.9	4.1
	mean	35.0	28.7	4.7
		Mean Bulb Diameter	**Mean Bulb Height**	**Mean Number of Cloves/Bulb**
	Cali Late	31.2	27.5	3.6
	LWG	38.9	30.5	5.3
	DWG	41.0	32.6	7.0
Statistical Significance				
Cultivar (A)		*	*	ns
Location (B)		*	*	ns
A x B Interaction		*	*	ns
LSD				
Cultivar & Location of Origin		2.8	1.7	-
CV & Location Interaction		4.9	2.9	-

† * denotes significance of $p \leq 0.05$ ns = not significant

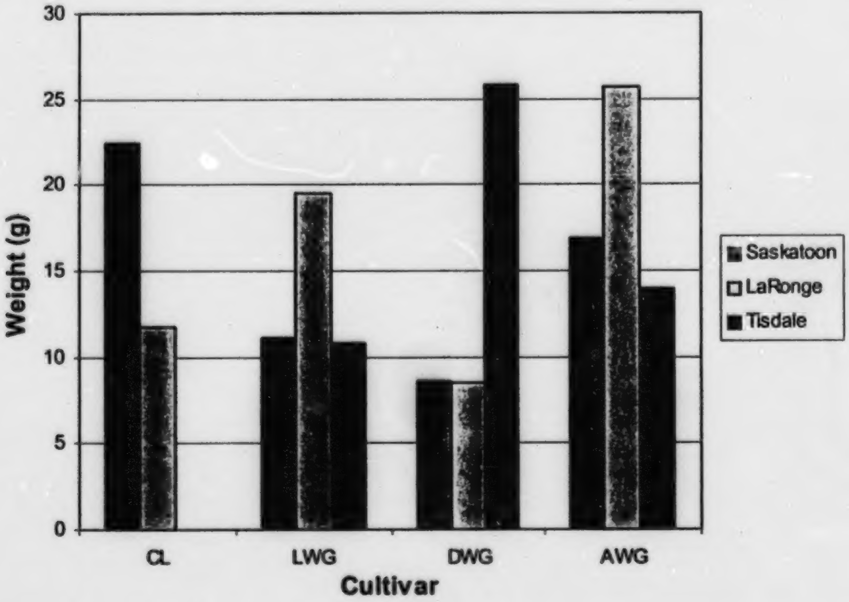


Figure 18. 3The mean bulb weight of garlic grown in La Ronge Saskatchewan.

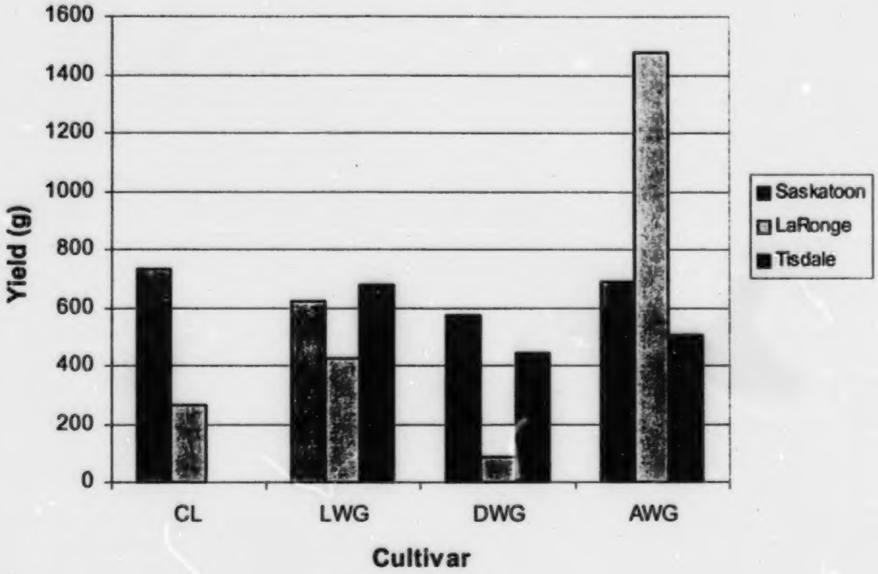


Figure 18. 4 Total yields of garlic grown in La Ronge, Saskatchewan.

18.3.3 Spring planting, Saskatoon 1999

Significant differences were noted between all measured parameters (Table 18.3). Cultivars CL – stiff, M & M, CE and DWG have significantly larger bulb diameters while AWG and Getz have the smallest bulb diameters. Height, weight and clove weight of bulbs is significantly larger in the M&M cultivar compared to other plants (Figs. 18.5, 18.6). However, clove number per bulb was lowest in the M&M cultivar (Fig. 18.7). All other cultivars except CL-Stiff and DWG-Stiff had greater than 6 cloves per bulb (Fig. 18.7).

Table 18.3 Differences between cultivars when comparing bulb diameter, bulb height, bulb weight, individual clove weight and the clove # per bulb of garlic grown in Saskatoon, Saskatchewan, 1999.

Location of Origin	Cultivar	Bulb Diameter (mm)	Bulb Height (mm)	Bulb Weight (g)	No. of Cloves / Bulb	Clove Weight (g)
Saskatoon	LWG	44.5	32.3	34.0	7.7	4.5
	CL	46.3	33.0	33.1	7.5	4.4
	DWG	47.8	33.0	38.9	7.1	5.6
	CE	50.3	36.8	36.5	6.3	5.9
	AWG	40.8	29.5	24.0	7.3	3.4
	M&M	51.8	42.5	53.3	2.5	24.6
	Getz	43.1	33.9	34.3	7.3	4.7
	CL-Stiff	50.6	36.9	45.5	3.9	14.5
	DWG-Stiff	42.9	31.3	28.6	5.7	5.8
Statistical Significance						
Cultivar		*	*	*	*	*
SD		3.24	3.26	8.83	1.09	3.50
CV%		5.41%	7.35%	18.77%	13.80%	33.27%

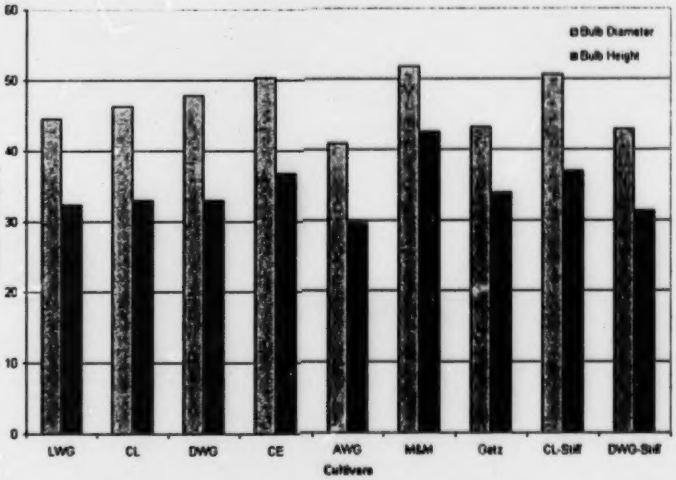


Figure 18. 5 Comparison of bulb heights and diameters between cultivars, 1999.

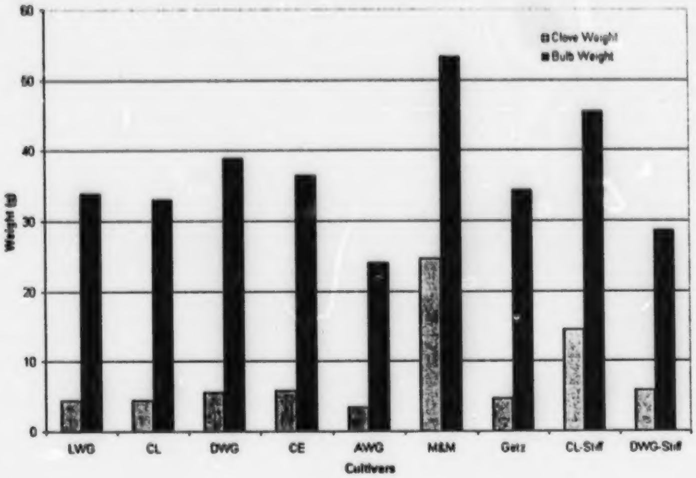


Figure 18. 6 Comparison of bulb and clove weights between cultivars, 1999.

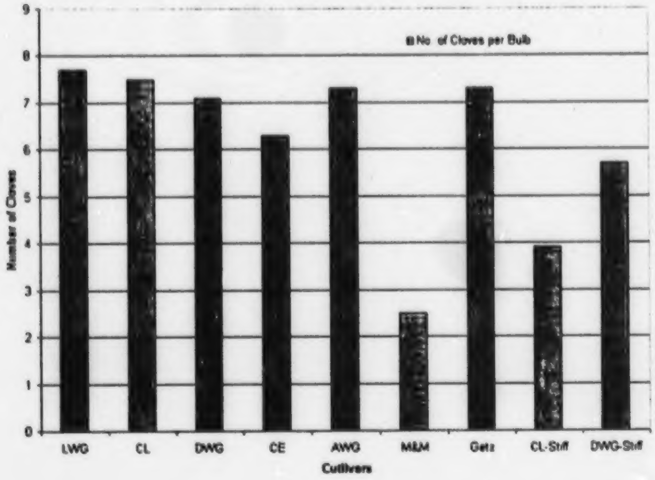


Figure 18. 7 Comparison of number of cloves per bulb between cultivars, 1999.

18.3.4 Fall planting, La Ronge 1999

Garlic was planted on October 22nd, 1999 and harvested on 30th of July in La Ronge, 2000. When sourced from La Ronge, there were no significant differences for bulb diameters among the six cultivars (Table 18.4). In comparing bulb height, DWG-stiff is significantly ($p \leq 0.01$) shorter than the other cultivars tested. CL-stiff has significantly ($p \leq 0.01$) heavier bulbs in comparison to the other cultivars with fewer number of cloves per bulb, and accordingly, clove weight was significantly ($p \leq 0.01$) higher.

When garlic was sourced from Saskatoon and grown in La Ronge, all parameters became significant (Table 18.5). CL-stiff had the greatest bulb diameter, and similar to the La Ronge-source, bulb height and bulb weight were higher than other cultivars. Number of cloves per bulb, however, was not the lowest as previously observed. Clove number was in the medium range while weight per clove was still double that of any other cultivar. The Chinese cultivars were not superior to any of the Saskatchewan or California cultivars tested in terms of the agronomic yield components tested.

Location of origin x cultivar interaction was only significant in terms of clove weight where both California late-stiff and DWG-stiff had a higher clove weight when sourced from Saskatoon compared to La Ronge, even when grown in La Ronge (Table 18.6). This is in contrast to our other results where response was generally superior when garlic was both sourced from and grown on, the same site. There were significant cultivar differences for bulb diameter irrespective of location of origin (Table 18.6).

Table 18.4 Comparison of six garlic lines planted in October, 1999 and grown in La Ronge in 2000.

Location of Origin	Cultivar	Bulb Diameter (cm)	Bulb Height (cm)	Bulb Weight (g)	No. of Cloves / Bulb	Clove Weight (g)
La Ronge	CE	4.57	3.77	33.21	6.80	5.06
	CL-stiff	5.03	4.43	51.95	4.93	11.46
	DWG-stiff	4.19	3.38	34.85	6.33	5.24
	CL	4.39	3.64	34.22	6.93	5.12
	LWG	4.44	3.75	31.05	7.40	4.45
	DWG	4.71	3.84	34.86	6.80	4.74
Statistical Significance		ns	**	**	**	**
Lsd $_{0.05}$			0.69	9.51	1.17	2.12
CV%		15.69%	17.46%	24.96%	17.38%	33.86%

**denotes significance levels of $p \leq 0.01$

Table 18.5 Comparison of eleven garlic lines planted in October, 1999 and grown in La Ronge, 2000.

Location of Origin	Cultivar	Bulb Diameter (cm)	Bulb Height (cm)	Bulb Weight (g)	No. of Cloves / Bulb	Clove Weight (g)
Saskatoon	DWG-stiff	4.39	3.24	29.11	7.53	4.24
	C-2	3.73	3.23	26.99	5.60	4.53
	CL	4.37	3.41	34.81	7.40	5.07
	LWG	4.08	3.31	28.76	6.87	4.43
	CL-stiff	4.97	4.41	53.29	5.67	11.68
	CE	4.47	3.20	32.54	6.13	5.27
	AWG	4.12	3.45	27.42	7.40	4.02
	C-4	3.95	3.05	23.83	5.53	4.38
	C-1	2.80	2.49	15.08	2.60	5.86
	C-3	3.45	2.30	19.55	5.13	3.91
	DWG	3.89	3.06	28.51	7.00	4.40
Statistical Significance		**	**	**	**	**
Lsd $_{0.05}$		0.54	0.39	7.71	1.59	2.44
CV%		13.71%	10.44%	24.79	26.45%	47.19

**denotes significance levels of $p \leq 0.01$

Table 18. 3 Effect of cultivar and location of origin on bulb diameter, bulb height and clove number of garlic, grown in La Ronge, 2000

Location of Origin	Cultivar	Bulb Diameter (mm)	Bulb Height (mm)	Bulb Weight (g)	No. of Cloves / Bulb
Saskatoon	California Early	4.47	3.20	32.6	6.13
	California Late Stiff	4.97	4.41	52.7	5.67
	DWG-Stiff	4.19	3.22	31.2	7.60
	California Late	4.37	3.41	36.7	7.40
	LWG	4.10	3.33	29.9	6.87
	DWG	3.91	3.06	29.8	7.00
La Ronge	California Early	4.59	6.53	33.8	6.80
	California Late Stiff	5.03	4.43	48.4	4.93
	DWG-Stiff	4.61	3.38	34.4	6.13
	California Late	4.59	3.44	35.5	6.93
	LWG	4.45	3.75	33.0	7.40
	DWG	4.51	3.84	35.5	7.20
Statistical Significance					
Cultivar		*	ns	**	ns
Location		ns	ns	ns	ns
Cultivar*Location		ns	ns	ns	*
LSD					
Cultivar		0.36	-	10.17	-
Cultivar*Location		-	-	-	1.02

† * and ** denote significance levels of $p \leq 0.05$ and $p \leq 0.01$ respectively; ns = not significant

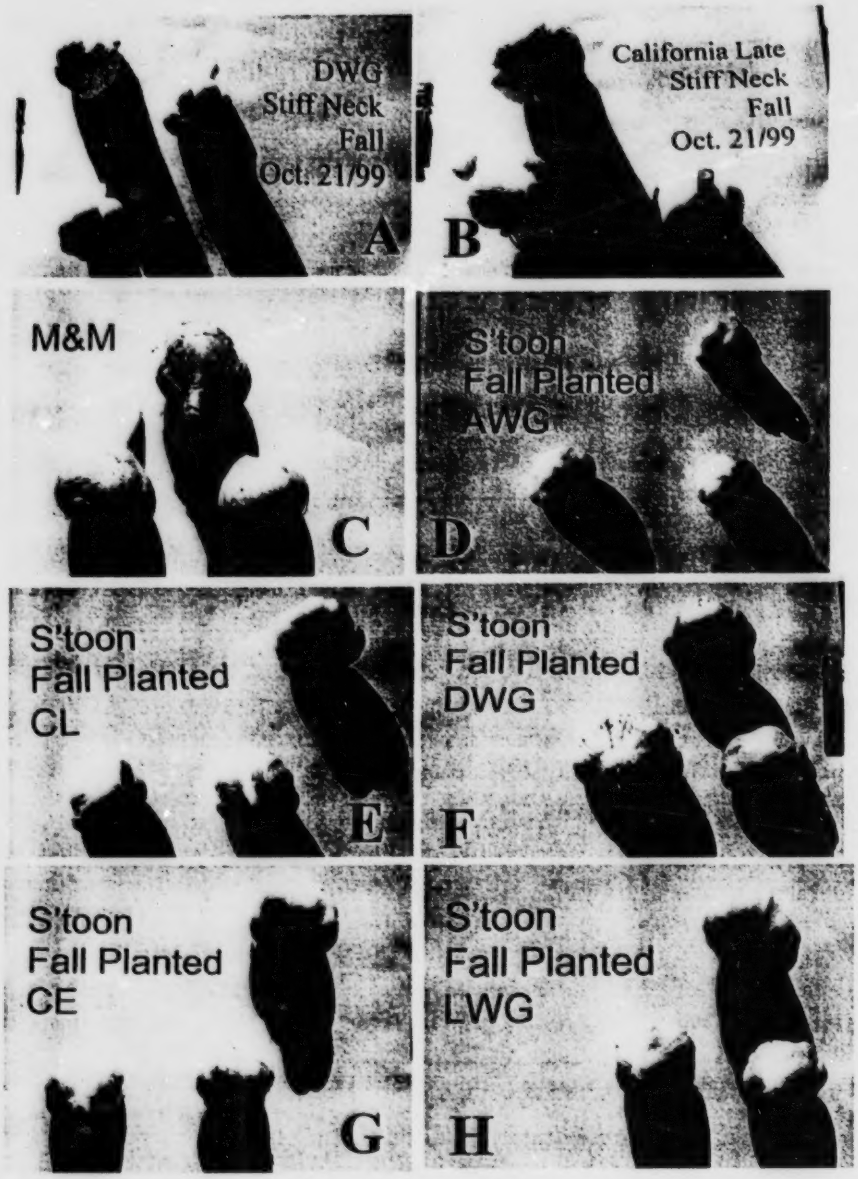

DWG
Stiff Neck
Fall
Oct. 21/99
A
California Late
Stiff Neck
Fall
Oct. 21/99
B
M&M
C
S'toon
Fall Planted
AWG
D
S'toon
Fall Planted
CL
E
S'toon
Fall Planted
DWG
F
S'toon
Fall Planted
CE
G
S'toon
Fall Planted
LWG
H

Figure 18. 8 Various garlic lines grown in Saskatoon, SK in 1999: DWG (A),. California Late Stiff Neck (B), M&M (C), AWG (D), California Late (E), DWG (F), California Early (G) and LWG (H)

18.3.5 Year Comparison, Saskatoon 1999, 2000

Saskatoon samples were placed on benches in an open unheated hoop house for drying down (Fig. 18.12). Problems arose during the drying process that resulted in some sample loss. However, these were removed and the remaining samples were measured for the necessary data.

Cultivar and year were non-significant for any of the parameters tested. However, the interaction was significant for bulb height, bulb weight and number of cloves per bulb (Table 18.7). Generally, when grown at the same site for more than one year, bulb height and weight, number of cloves increased in the second year.

Table 18. 4 Comparison of bulb diameter, bulb height and clove number of garlic for garlic lines tested in 1999 & 2000 in Saskatoon.

Year	Cultivar	Bulb Diameter (mm)	Bulb Height (mm)	Bulb Weight (g)	No. of Cloves / Bulb
One	LWG	4.48	3.25	38.77	7.9
	California Late Stiff	5.17	3.65	47.49	4.1
	DWG	4.98	3.28	42.76	7.4
	California Late	4.73	3.28	35.45	7.7
	AWG	4.17	2.98	25.71	7.2
Two	LWG	4.22	3.51	33.18	6.9
	California Late Stiff	4.95	4.47	53.38	6.0
	DWG	4.00	3.18	30.51	6.6
	California Late	4.40	3.34	37.07	7.5
	AWG	2.99	3.51	31.99	7.9
Statistical Significance					
Cultivar		ns	ns	ns	ns
Year		ns	ns	ns	ns
Cultivar*Year		ns	**	*	*
LSD					
Cultivar		-	-	-	-
Cultivar*Year		-	0.33	8.79	1.31

† * and ** denote significance levels of p≤0.05 and p≤ 0.01 respectively; ns = not significant

Figure 18. 9 La Ronge, SK fall garlic plots July, 2000.

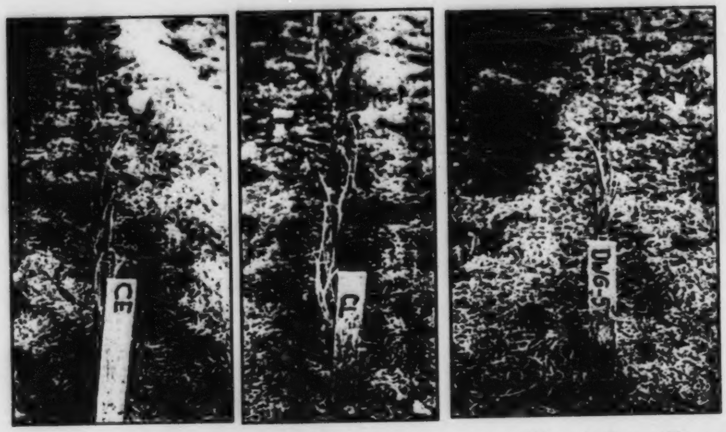


Figure 18. 10 Garlic lines California Early (A), California Late (B), and DWG (C) at La Ronge, SK 2000.

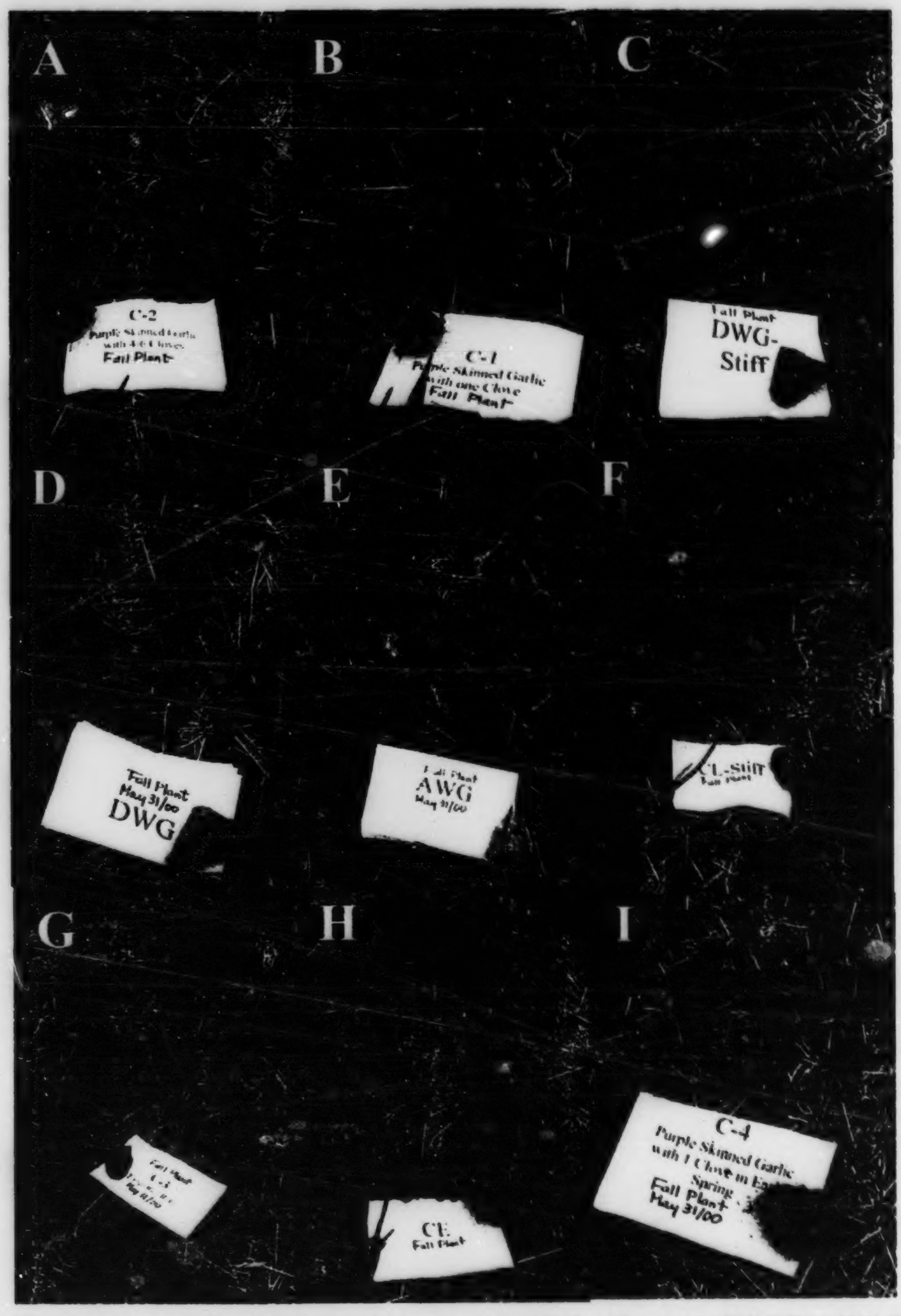

A
B
C
C-2
Purple Skinned Garlic with 4-6 Clove
Fall Plant
C-1
Purple Skinned Garlic with one Clove
Fall Plant
Fall Plant
DWG-Stiff
D
E
F
Fall Plant
May 31/00
DWG
Fall Plant
AWG
May 31/00
CL-Stiff
Fall Plant
G
H
I
Fall Plant
C-3
May 31/00
CE
Fall Plant
C-4
Purple Skinned Garlic with 1 Clove in Early Spring
Fall Plant
May 31/00

Figure 18. 11 Garlic lines Chinese garlic #2 (A), #2 (B), DWG-stiff neck (C), DWG (D), AWG (E), California Late stiff neck (F), Chinese garlic #3 (G), California Late, (H) and Chinese garlic #4 (I) at Saskatoon, SK in June, 2000.

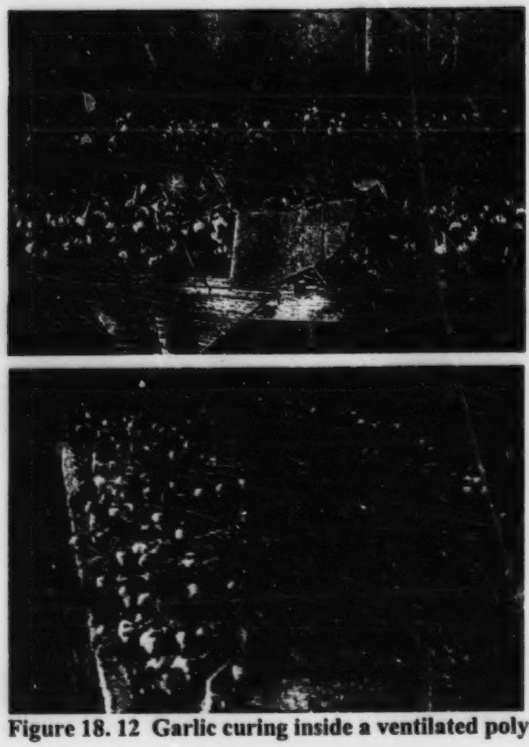
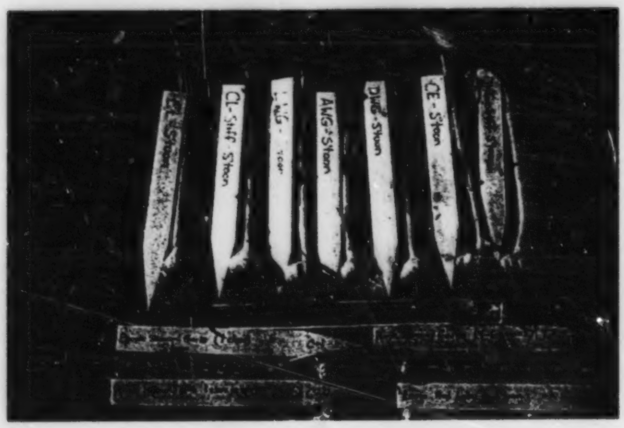


Figure 18. 12 Garlic curing inside a ventilated poly-greenhouse at Saskatoon, SK 2000.



CL-Stiff S'toon
AWG-S'toon
DWG-S'toon
CE-S'toon

Figure 18. 13 Curing garlic lines from Saskatoon, SK. 2000

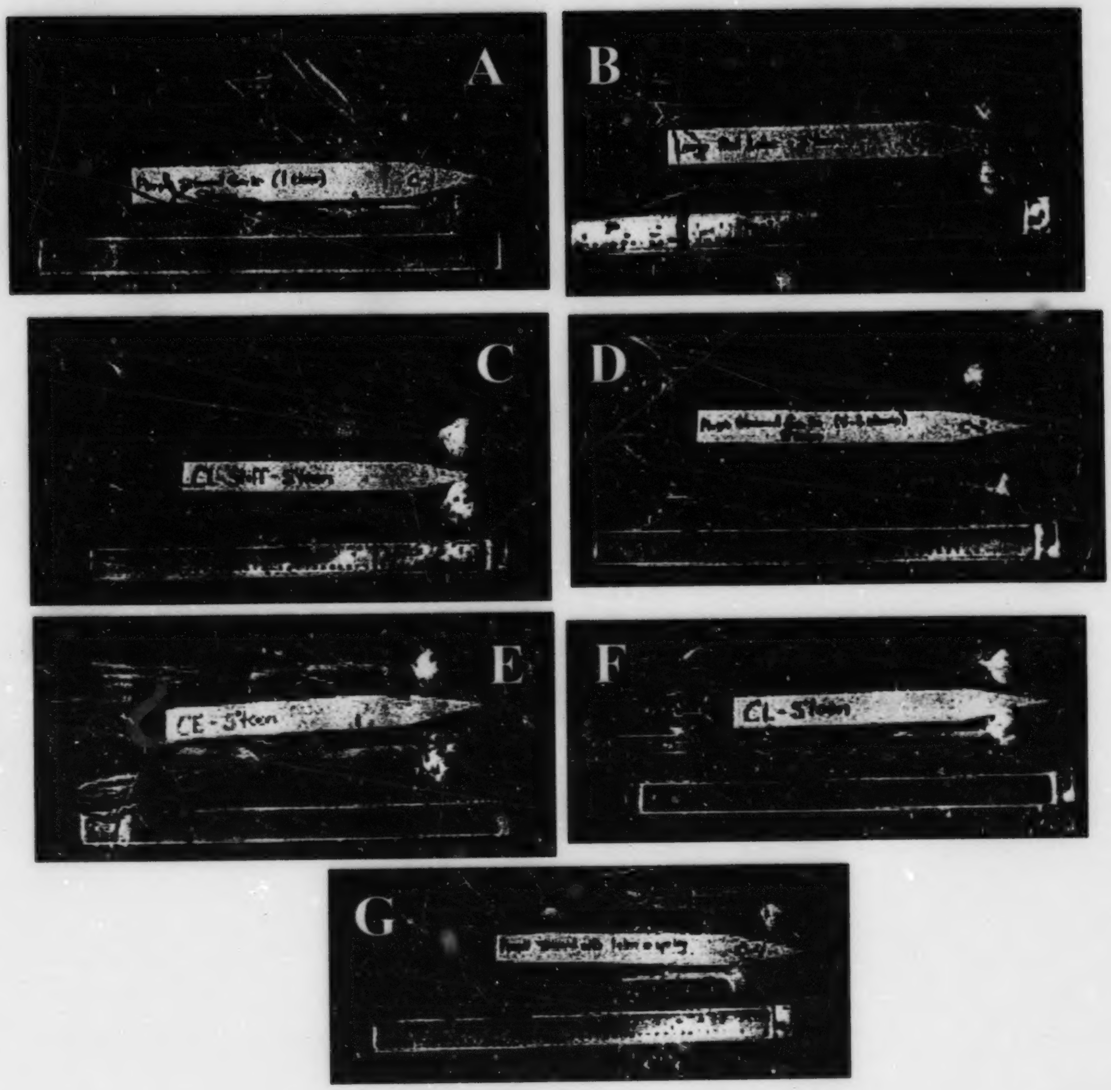

A
B
C
CL-Stiff-5 stem
D
E
CE - 5 stem
F
CL-Stem
G

Figure 18. 14 Curing garlic lines of Chinese garlic #1 (A), #3 (B), California stiff neck (C), Chinese garlic #2 (D), California Early (E), California Late (F) and Chinese garlic #4 in Saskatoon, SK.

18.4 Conclusions

In general, significant differences in mean bulb weight, bulb diameter and total bulb yields among cultivars were noted. These differences contributed to main effects of cultivar, location of origin and also the interaction between the two factors. California-late Stiff, M&M and DWG generally tend to produce larger cloves and higher bulb yield compared to other cultivars. It appears that cloves originating from La Ronge tend to have an increased bulb size, but bulbs originating from Saskatoon tend to produce higher bulb yield than La Ronge. This yield improvement could be due to heavier cloves produced in Saskatoon over La Ronge. Further studies are required to elucidate the impact of latitude on bulb yield components of garlic.

M & M garlic purchased from Dave & Krista McBain, of Whitefox, and California late-Stiff are superior to the other cultivars in terms of size and weight. This variety would be useful for processing since it has few cloves with ample amounts of flesh. AWG and Getz may be useful for the fresh market due to the large number of cloves, however, clove size was relatively small. LWG, CL, CE and DWG may be more desirable since these cultivars produce an adequate number of cloves while maintaining their weight, providing a slightly larger bulb and clove to the consumer. The Chinese cultivars were not superior to any of the Saskatchewan or California cultivars tested in terms of agronomic yield components, however, our other tests indicate superior alliin and allicin content.

Adaptation to growth in one location generally appears to be an important factor. However, bulbs sourced from Saskatoon have subsequently induced superior responses when grown in other sites.

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APPENDICES

Hourly air temperatures at La Ronge, Saskatchewan Canada for August 1998.

August, 1998 La Ronge Hourly Temperature Summary - Dry Bulb Air Temperature (0.1°C).

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	195	185	152	146	138	139	142	168	196	200	204	216	227	234	248	267	271	273	271	265	252	232	219	219
2	211	201	202	193	180	174	182	195	207	217	230	245	258	268	272	276	268	272	274	260	248	220	199	177
3	160	150	135	134	133	123	152	170	209	229	255	278	289	298	305	278	281	279	272	273	257	230	221	209
4	203	180	180	155	145	136	159	190	217	254	279	300	305	311	310	320	315	311	303	295	82	259	257	232
5	225	224	222	218	219	208	204	206	223	240	261	259	282	317	331	348	345	343	338	324	285	281	265	241
6	235	225	218	218	213	217	214	219	230	254	278	304	318	334	335	349	330	328	313	291	278	247	230	208
7	171	187	184	164	132	112	108	152	187	213	232	241	250	268	273	277	284	272	272	255	242	201	175	183
8	178	170	171	164	158	164	162	170	171	173	189	201	216	238	248	256	262	260	258	253	240	211	192	186
9	175	144	128	140	118	108	98	114	149	188	215	233	243	247	256	278	275	273	268	255	230	214	186	187
10	193	193	189	175	163	178	180	163	194	215	226	255	274	287	291	297	294	293	289	276	265	251	242	231
11	227	222	223	205	205	187	180	190	215	213	219	226	246	257	265	276	289	293	280	272	258	225	193	199
12	212	196	183	175	157	156	157	159	182	211	224	228	225	218	202	220	240	255	255	258	230	183	166	157
13	156	161	154	155	147	156	148	151	154	163	165	161	160	156	171	174	175	171	176	148	149	150	144	126
14	102	102	94	106	98	95	93	103	130	157	172	189	185	191	207	214	212	215	208	196	186	169	162	158
15	143	143	138	131	119	130	153	157	149	145	153	153	153	151	146	153	156	155	159	155	146	136	133	112
16	116	119	111	118	119	121	119	124	138	134	142	144	144	146	156	160	163	164	163	163	157	151	153	147
17	144	143	142	138	134	127	130	139	142	155	169	170	200	209	215	212	228	220	217	212	201	190	182	175
18	169	165	166	168	166	158	157	155	158	170	182	189	202	216	220	227	226	243	239	243	218	189	152	145
19	124	112	101	95	125	126	138	154	153	181	196	213	225	226	215	197	194	194	191	175	171	153	146	123
20	120	79	66*	54*	50*	40*	40*	58*	87	131	143	147	166	149	149	152	153	159	161	155	145	111	111	102
21	82	84	130	134	122	128	101	121	163	179	192	211	221	240	238	238	240	239	233	226	221	211	189	189
22	183	184	186	179	160	161	165	174	180	189	200	204	215	228	228	229	246	228	222	209	186	184	173	164
23	164	157	153	142	143	136	136	137	156	183	204	217	225	232	239	244	252	248	245	233	207	167	135	117
24	113	120	130	135	129	128	110	144	147	169	193	222	232	244	218	215	242	194	209	72	157	134	133	119
25	121	118	107	99	93	87	76	96	124	153	169	183	193	213	208	213	218	218	213	196	172	131	122	101
26	97	93	78	87	80	132	147	155	159	170	175	205	221	236	236	234	225	202	193	191	192	153	150	143
27	135	137	137	131	121	111	108	119	126	142	151	153	175	195	208	216	214	209	208	201	195	171	164	187
28	154	154	147	144	150	139	134	131	146	160	176	190	201	209	218	218	221	216	215	204	188	168	153	125
29	119	109	93	84	68*	65*	56*	78	131	166	189	204	222	235	244	250	251	242	232	219	198	180	175	169
30	172	170	157	142	148	129	123	112	170	197	236	251	276	261	244	244	242	263	261	251	226	218	206	186
31	174	166	147	127	123	129	123	122	131	144	154	165	176	175	178	188	186	180	171	157	146	129	109	93

Hourly air temperatures at La Ronge, Saskatchewan Canada for September 1998.

September, 1998 La Ronge Hourly Temperature Summary - Dry Bulb Air Temperature (0.1°C).

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	84	86	72	74	62	48*	51*	55*	85	113	131	139	153	159	168	171	174	179	163	156	135	120	119	133
2	144	137	136	135	135	137	131	135	145	151	161	172	185	200	210	221	215	226	210	204	195	182	172	169
3	166	156	146	140	157	157	160	156	157	168	179	202	209	216	216	222	224	216	211	193	155	121	94	84
4	68*	62*	59	70*	51*	58*	78	83	121	141	139	133	153	177	206	194	206	198	193	182	157	135	106	84
5	111	111	105	99	91	84	74	77	104	131	156	177	185	193	193	190	202	199	184	177	160	136	121	97
6	82	74	69*	60*	73	63*	49*	58*	96	127	142	149	163	178	174	186	189	188	179	156	127	92	105	130
7	135	129	127	124	120	113	112	117	125	132	145	162	169	183	207	203	211	209	202	189	177	171	166	167
8	158	152	149	148	147	149	147	145	141	144	146	157	158	165	159	164	188	184	182	175	164	152	129	107
9	98	90	95	96	98	109	116	117	119	120	126	136	147	168	196	205	20	206	196	182	172	165	147	142
10	139	136	135	130	131	132	132	132	132	139	151	166	171	182	192	199	192	190	192	171	134	128	132	132
11	121	115	115	108	99	88	82	82	105	123	143	171	175	187	196	205	203	195	186	178	178	174	167	165
12	152	152	151	143	136	130	119	110	127	146	159	184	187	202	202	212	218	211	205	183	138	106	99	84
13	94	125	132	129	135	134	139	142	155	174	177	182	179	182	208	203	190	184	189	181	162	152	140	128
14	113	109	107	102	93	92	106	84	97	101	124	136	133	140	134	152	146	142	143	122	111	79	69*	56
15	69*	81	82	86	84	108	115	121	122	138	144	151	169	180	198	196	195	184	176	173	141	116	111	99
16	98	88	85	75	72	69*	76	90	97	103	102	102	114	122	141	147	142	136	130	130	130	127	126	125
17	121	101	100	104	100	84	87	87	89	98	106	115	120	119	121	129	131	125	117	95	63*	27*	6*	-12
18	-15	-18	-20	-24	-32	-25	-10	-27	11*	69*	83	94	106	103	115	127	131	136	131	117	108	107	93	88
19	84	88	88	78	84	84	90	88	95	97	108	117	117	120	126	128	130	134	135	117	69*	44*	25*	19*
20	9*	8*	1*	-5	-6	-9	-19	-28	27*	68*	107	134	146	148	150	146	147	149	141	122	110	408	103	98
21	94	86	85	80	75	72	68*	51*	62*	77	100	128	135	157	166	170	171	171	162	144	137	126	109	104
22	104	89	77	75	83	82	67*	61*	74	99	125	129	158	180	190	197	195	184	172	151	124	113	101	100
23	77	45*	35*	26*	39*	33*	18*	24*	51*	79	103	126	135	142	140	143	145	148	138	113	94	98	113	113
24	106	105	107	83	86	89	87	70*	68*	102	109	118	129	119	117	93	84	86	84	77	69*	65*	62*	68*
25	44*	15*	7*	-7	-14	-16	-4	-24	-5	58*	73	80	91	102	97	112	114	111	104	79	32*	17*	79	72
26	70*	63*	55*	59*	46*	55*	60*	60*	46*	58*	71	72	78	81	85	85	95	92	91	72	65*	67*	80	84
27	82	77	55*	74	73	63*	68*	50*	62*	84	101	118	129	135	137	139	141	134	113	88	83	83	79	78
28	80	77	78	78	77	77	61*	65*	65*	70*	80	83	85	98	97	96	93	104	93	84	67*	66*	57*	38*
29	25*	18*	26*	47*	51*	51*	52*	47*	46*	56*	55*	66*	76	81	84	89	83	83	72	54*	49*	39*	36*	9*
30	43*	43*	38*	39*	40*	40*	35*	36*	37*	48*	49*	54*	88*	73	82	91	88	87	73	49*	14*	-10	-7	8*

* denotes tempertures used in chilling hour calculation

Hourly air temperatures at Gerber, California USA for August 1998.

August, 1998 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	19.0	18.0	19.0	19.0	17.9	18.9	21.5	24.3	27.2	29.8	32.5	34.4	35.6	36.6	37.3	37.6	37.6	37.5	35.2	27.0	22.2	21.2	19.9	18.4
2	18.1	18.3	19.0	19.3	17.2	15.8	20.2	24.9	28.2	29.6	32.1	33.6	35.6	37.0	38.6	39.8	39.6	37.4	34.8	29.0	24.9	23.2	22.5	22.6
3	23.2	23.5	23.0	21.7	22.6	22.6	24.6	27.5	30.4	33.0	36.2	37.7	39.1	40.8	41.4	41.7	41.1	39.0	34.9	29.8	25.5	24.3	22.9	21.5
4	20.7	20.4	19.2	19.6	20.5	18.9	22.9	27.6	31.0	34.4	35.5	36.7	38.0	39.0	39.4	39.9	40.1	38.7	35.3	28.6	25.8	24.8	23.7	22.9
5	21.6	21.2	20.0	20.7	20.3	20.2	24.4	27.2	30.7	34.2	36.2	37.7	38.3	38.8	38.8	38.3	37.6	37.1	34.3	28.8	27.1	27.3	25.0	25.3
6	24.4	23.0	22.8	22.6	21.7	21.4	24.8	28.6	31.1	33.8	35.2	36.4	35.5	35.5	35.6	35.6	35.0	34.1	31.4	27.1	26.4	26.7	25.6	22.5
7	20.0	19.6	18.1	17.2	16.5	16.6	21.0	23.4	26.3	29.5	31.2	32.5	33.5	33.7	33.5	33.0	32.2	31.5	28.8	24.0	21.3	21.7	20.9	19.6
8	19.2	17.5	16.8	15.3	14.8	15.2	19.4	23.1	25.1	27.1	28.8	29.7	30.9	31.5	31.7	31.2	30.6	29.7	26.7	24.3	19.9	20.3	19.5	18.3
9	17.6	16.7	16.4	15.4	15.0	14.8	18.4	22.0	25.5	28.3	30.5	31.9	32.4	32.7	33.0	33.0	32.7	32.0	28.7	22.7	20.4	19.3	17.5	16.7
10	16.4	16.2	17.0	15.6	15.6	16.1	19.2	22.7	26.2	28.8	31.7	34.2	35.9	36.6	36.9	36.1	35.7	34.1	30.3	24.1	22.0	20.7	18.6	18.1
11	16.8	17.3	17.0	16.2	17.3	17.6	20.2	23.5	27.0	30.9	33.2	35.4	37.6	38.1	38.8	39.0	38.3	36.1	32.1	26.4	23.7	21.9	21.2	19.6
12	19.1	19.0	18.2	18.0	18.0	17.9	21.8	26.5	29.8	32.3	34.7	36.7	38.7	40.3	40.6	39.5	37.4	34.8	31.4	27.0	24.7	23.7	23.0	22.1
13	21.5	22.2	22.2	21.6	20.2	21.3	24.1	27.4	30.2	33.1	35.8	38.3	39.3	38.9	38.2	38.2	37.4	35.3	32.0	27.6	25.8	25.9	25.5	23.9
14	24.2	23.6	22.6	21.6	21.5	21.2	24.6	28.2	30.6	32.7	34.9	37.1	36.9	36.6	36.8	36.6	36.1	35.0	32.8	27.6	25.3	26.1	25.9	23.1
15	22.4	21.9	21.6	20.6	20.1	19.6	22.9	24.7	27.5	29.9	31.5	32.7	33.9	34.8	34.4	33.7	33.0	31.7	28.5	24.5	24.1	23.8	24.1	22.4
16	20.4	19.2	18.5	18.2	16.8	17.0	20.5	23.9	25.5	27.8	29.1	30.6	31.6	32.2	32.3	31.9	30.9	29.5	26.9	23.9	22.6	21.4	20.9	20.9
17	19.7	18.8	18.0	17.2	16.6	16.1	17.9	20.1	22.0	24.2	26.2	27.7	28.7	29.1	28.9	28.7	27.4	26.1	24.3	21.0	19.9	19.8	19.3	18.4
18	17.6	16.8	15.7	14.6	14.3	14.5	15.6	18.2	20.5	22.5	24.3	26.0	27.3	28.0	28.8	28.7	27.6	26.3	22.9	19.7	18.7	17.4	16.6	16.3
19	15.7	15.2	14.7	14.2	13.4	13.3	15.4	18.5	20.8	23.6	25.8	27.5	29.0	30.1	30.6	30.5	29.4	27.6	23.8	20.5	18.5	17.5	17.0	16.5
20	15.9	15.7	15.7	14.7	14.2	13.6	15.0	18.2	20.2	22.9	25.4	27.4	28.8	29.6	30.1	29.6	29.0	27.6	24.1	19.1	17.6	17.2	15.8	14.9
21	14.5	13.3	12.7	12.4	12.4	11.9	15.1	18.5	21.8	24.8	26.9	28.6	30.5	31.4	32.2	32.1	31.5	30.0	26.6	20.8	19.1	17.6	16.2	14.6
22	13.9	13.3	13.4	13.5	13.2	13.3	15.9	19.8	23.2	26.7	28.7	31.0	32.6	33.4	33.4	33.0	32.2	30.1	26.2	22.8	22.5	19.7	18.7	18.0
23	17.3	16.5	15.6	17.0	14.7	13.8	16.8	20.8	22.8	25.6	28.0	30.2	32.1	33.4	34.2	35.0	35.7	33.0	29.4	22.7	19.3	17.9	17.2	15.8
24	15.6	14.5	13.9	13.3	12.5	12.2	16.2	20.8	24.7	28.6	30.0	32.2	33.6	34.3	34.5	34.1	33.0	30.8	26.9	23.4	20.1	19.6	18.1	17.7
25	17.0	16.8	15.7	15.8	13.8	13.1	16.6	21.2	25.0	27.3	29.2	30.8	31.1	31.4	31.5	31.0	30.4	28.9	25.3	20.8	18.1	17.6	18.6	16.1
26	15.0	14.0	14.1	13.1	13.1	12.7	15.0	20.1	21.3	25.0	27.1	29.6	31.7	32.5	33.5	33.3	33.3	31.5	25.6	21.3	19.0	16.8	16.1	15.1
27	14.3	13.8	13.8	14.6	14.9	15.2	17.1	20.2	24.4	27.7	29.6	31.3	32.9	34.1	34.7	34.7	33.7	31.2	27.4	22.0	19.5	18.1	16.8	16.0
28	15.1	14.6	14.8	15.4	14.8	14.8	17.1	21.4	25.2	28.8	31.6	34.4	35.3	36.2	36.5	36.0	34.8	33.6	29.5	22.9	21.1	19.5	18.3	17.9
29	17.5	18.0	18.5	18.0	16.9	17.0	19.0	22.7	26.5	29.6	31.8	34.5	37.1	37.4	37.8	37.2	37.2	35.5	29.0	24.5	23.9	22.5	21.5	20.9
30	19.9	19.2	19.0	19.5	18.7	17.1	19.6	24.1	27.8	30.8	33.4	35.1	36.0	37.3	37.2	37.4	37.6	35.3	29.3	23.9	21.0	19.7	19.1	18.8
31	20.0	19.0	19.8	19.7	18.6	18.7	21.8	25.0	28.3	31.6	34.6	37.2	39.5	40.4	41.9	41.7	41.9	40.3	34.2	27.5	24.4	23.4	21.9	20.2

Hourly air temperatures at Gerber, California USA for September 1998.

September, 1998 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	20.7	18.9	18.2	17.2	16.8	16.2	18.5	23.2	27.3	30.6	33.6	36.6	38.3	40.2	40.2	40.9	40.7	39.4	32.2	27.0	24.4	24.0	22.7	21.7
2	20.4	20.1	18.7	18.0	17.6	16.7	19.4	25.0	27.6	30.2	32.2	34.5	36.6	37.7	39.8	41.0	41.4	39.4	31.6	26.8	25.1	22.8	23.1	25.4
3	25.2	23.0	21.1	20.4	20.4	20.5	22.1	25.5	29.5	32.6	34.4	36.0	38.2	38.8	38.4	37.2	35.8	33.1	29.8	27.1	25.0	24.0	23.0	22.3
4	23.5	23.2	23.6	23.1	23.1	22.7	24.0	27.0	29.6	31.5	32.4	33.6	34.0	34.7	34.9	34.5	33.4	31.5	30.1	29.6	28.9	28.5	26.8	26.0
5	24.4	23.7	22.8	21.9	21.6	21.7	21.5	22.1	23.5	24.9	26.3	27.4	27.5	27.6	28.0	28.3	29.1	27.5	25.0	24.0	23.4	23.1	22.7	22.0
6	21.5	21.8	22.3	22.6	23.0	22.9	22.7	25.0	27.1	29.1	29.4	31.5	33.5	34.0	33.8	34.1	31.2	30.9	29.7	26.4	24.7	24.4	23.6	23.3
7	23.1	22.6	22.0	21.4	20.9	20.6	22.3	25.3	28.8	31.0	32.4	33.1	33.8	33.8	35.0	32.5	30.8	30.5	28.4	27.1	26.5	25.3	24.9	24.5
8	24.0	21.5	19.8	19.0	19.3	18.6	20.9	24.3	25.7	28.2	29.7	30.9	31.5	31.7	32.1	31.9	31.1	29.2	26.6	26.4	25.3	24.6	23.0	21.1
9	21.1	20.2	19.3	18.5	17.1	16.3	16.4	17.7	18.6	19.3	20.4	21.7	22.8	23.2	23.9	24.2	23.8	20.9	17.6	16.7	16.6	15.3	16.2	15.9
10	13.7	13.7	12.4	12.7	12.6	12.8	14.1	16.8	19.6	22.0	24.6	26.7	28.1	29.0	29.7	30.0	29.8	28.6	25.2	22.0	21.7	20.0	18.8	18.1
11	17.8	18.4	18.5	18.1	18.6	18.8	20.7	23.0	25.3	27.6	29.4	30.8	31.6	32.6	33.5	33.8	33.6	32.7	29.1	27.0	24.5	25.3	23.1	20.5
12	19.4	17.6	16.6	15.8	15.7	17.0	18.4	23.4	26.4	29.4	31.6	33.3	34.5	35.0	35.4	35.4	35.2	33.2	27.9	26.0	24.5	22.5	23.4	23.4
13	22.7	21.8	21.5	20.6	20.4	20.2	21.3	24.1	27.1	29.8	32.4	34.6	36.1	37.2	38.1	38.5	37.5	35.1	28.8	24.8	22.0	22.9	21.2	19.3
14	18.3	17.6	18.2	18.3	18.2	18.2	20.0	23.2	26.5	28.8	30.7	33.0	34.9	34.6	34.8	34.7	33.7	31.3	26.0	23.6	22.7	21.8	20.9	19.9
15	19.9	20.1	20.5	20.4	19.1	19.3	21.0	[illegible]	25.4	29.5	32.0	32.8	33.7	33.9	33.9	33.4	33.3	31.4	26.0	23.2	22.6	22.0	20.8	19.7
16	19.2	17.8	17.2	16.3	16.5	15.6	17.0	21.6	24.4	26.6	28.8	30.3	31.1	31.6	32.3	32.4	31.7	29.1	24.5	22.0	20.7	20.2	20.6	21.5
17	22.1	20.1	18.6	17.8	15.2	14.0	14.8	18.6	20.4	22.6	24.4	25.7	27.0	28.4	28.8	28.6	27.8	26.2	24.1	20.4	17.8	17.5	17.7	18.2
18	16.7	15.2	13.7	12.9	12.4	12.9	15.1	17.1	19.9	21.5	23.2	24.1	25.2	26.0	26.7	27.1	26.8	25.3	22.4	21.7	21.4	18.8	18.2	16.1
19	17.5	18.0	18.0	17.9	18.3	18.3	18.7	20.4	21.9	23.2	24.7	26.1	26.6	27.7	28.2	27.9	27.5	26.5	24.7	24.4	23.0	23.2	22.5	21.8
20	21.4	20.5	19.7	19.1	18.1	18.0	18.8	21.0	22.5	24.2	25.7	27.4	28.8	29.8	30.1	30.2	29.6	27.2	21.2	19.4	17.5	16.6	15.0	14.6
21	14.7	14.1	12.4	11.5	11.3	10.8	12.1	17.2	19.3	22.0	24.2	26.1	28.4	29.8	30.0	29.9	28.2	24.6	20.5	18.5	18.3	16.2	14.6	14.4
22	13.9	13.3	13.3	12.0	11.2	11.8	13.1	15.9	18.3	20.3	22.3	23.9	25.1	25.9	26.1	25.9	25.1	22.3	18.9	17.6	17.2	17.2	16.8	15.9
23	14.6	14.1	15.0	13.1	12.8	12.5	12.5	14.2	17.5	20.9	22.5	23.4	24.8	24.9	24.5	24.4	23.5	21.3	19.2	18.9	16.7	15.7	15.0	14.6
24	14.1	13.7	12.9	12.1	11.5	10.6	11.4	16.1	17.9	19.7	21.7	23.2	24.3	25.1	25.4	25.0	24.1	22.4	19.8	18.6	17.3	17.0	16.6	15.4
25	14.7	15.3	15.4	15.0	14.8	14.5	14.1	14.2	15.1	15.9	17.6	19.1	20.1	20.5	20.5	20.2	20.0	19.2	18.4	17.9	17.6	17.2	16.6	16.4
26	15.8	15.2	13.9	13.2	13.6	12.6	12.3	13.0	14.0	17.4	19.2	22.0	23.5	24.0	24.0	23.0	20.0	18.4	15.4	14.1	13.1	12.6	12.2	11.2
27	10.3	10.7	10.1	9.0	8.8	9.3	10.7	12.2	13.2	13.7	14.2	15.1	15.8	16.9	17.5	17.4	16.9	15.9	14.6	14.0	13.6	12.8	12.5	11.7
28	11.4	10.8	10.8	10.2	9.6	9.3	9.8	12.5	15.7	18.7	21.0	22.7	24.3	25.5	26.0	26.4	25.2	21.7	18.4	17.1	15.9	15.1	13.7	12.4
29	12.1	11.9	11.2	12.1	12.5	12.6	13.4	16.5	19.4	22.0	24.7	25.8	25.5	25.8	25.7	25.4	24.2	22.4	20.7	19.1	17.6	17.2	14.2	14.3
30	13.1	13.0	12.9	12.7	11.7	10.9	11.8	14.3	16.6	18.9	21.0	22.8	23.9	24.4	24.6	24.6	23.5	21.1	18.1	17.2	17.2	16.4	14.7	14.9

Hourly air temperatures at Gerber, California USA for October 1998.

October, 1998 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	14.5	13.9	13.8	13.7	14.1	12.8	12.5	14.7	16.4	18.1	20.1	21.8	22.6	22.8	23.5	22.4	21.9	20.3	18.3	17.5	15.8	15.1	14.4	14.3
2	13.4	12.3	11.4	11.0	11.4	11.8	12.3	13.2	14.0	15.6	17.7	18.9	20.3	21.2	21.8	21.3	20.3	18.1	15.9	14.1	14.1	13.7	14.3	14.3
3	14.3	14.1	14.9	14.8	12.0	10.8	10.5	13.4	17.2	18.5	20.0	20.8	21.7	22.6	22.9	22.6	21.0	17.6	14.7	13.1	11.6	11.1	10.3	9.4
4	9.1	8.6	8.3	9.1	8.7	8.3	9.4	11.9	14.9	17.7	20.7	22.1	22.7	23.6	24.3	24.8	24.4	22.7	20.9	19.8	18.7	16.3	16.0	15.1
5	14.2	14.8	12.8	12.6	12.8	13.4	13.8	16.7	19.7	21.9	23.9	25.7	27.1	28.4	29.2	29.8	29.2	25.8	22.1	21.5	20.2	17.1	16.8	15.1
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July hourly temperatures for Fall River Nursery in McArthur, CA 1999 (°C).

July, 1999 McArthur, CA for Hourly of Chilling at Fall River Nurseries, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	14.7	12.8	12.1	11.5	10.9	12.7	16.4	19.5	21.8	23.9	25.6	27.2	28.5	29.5	30.4	29.7	29.3	29.0	26.9	21.7	20.1	17.5	15.7	12.4
2	12.1	11.0	11.6	10.5	9.5	11.1	14.4	16.3	18.6	20.5	22.0	23.0	25.0	25.6	25.7	25.5	24.9	23.8	21.9	20.4	17.1	14.6	13.9	13.5
3	13.8	12.6	10.3	8.2	7.7	8.8	11.4	13.9	15.3	17.0	18.6	19.0	19.2	19.6	20.0	19.6	19.0	17.3	16.0	13.8	12.1	10.9	10.3	9.8
4	9.5	8.8	8.3	5.0	4.5	6.2	9.5	12.1	13.3	14.9	16.5	17.9	19.3	20.4	22.0	23.1	23.5	22.8	20.4	15.8	13.2	12.2	10.9	10.2
5	9.8	5.5	6.4	6.4	3.9	6.2	11.4	15.0	18.7	21.0	23.4	25.4	26.9	28.3	29.1	28.7	28.0	27.0	25.1	21.4	17.3	15.3	12.8	10.7
6	8.8	7.3	8.1	5.8	4.8	7.2	11.1	14.7	18.1	21.9	24.7	26.6	28.5	29.1	29.0	28.7	28.0	26.7	24.5	20.4	17.1	16.3	15.8	14.3
7	14.8	12.0	9.3	10.2	9.6	10.8	13.7	15.8	17.6	19.1	20.7	22.0	23.0	23.8	24.1	24.9	24.2	23.0	20.9	18.9	17.4	13.8	12.5	12.0
8	11.5	9.2	7.9	7.0	7.1	8.3	12.7	16.3	19.8	22.5	24.7	26.7	28.1	29.3	30.6	30.6	29.3	27.9	25.4	22.4	21.0	16.8	14.6	13.9
9	11.8	10.5	8.4	7.7	7.3	8.7	13.0	16.0	19.3	22.6	25.9	28.2	29.8	30.7	32.1	31.4	30.6	29.2	26.5	20.9	19.0	14.2	13.3	10.8
10	9.7	8.6	8.3	7.7	7.5	9.6	13.9	18.0	21.7	25.4	27.0	29.5	32.1	33.8	34.7	34.5	33.4	32.1	29.3	25.3	22.9	20.6	19.3	16.9
11	15.6	13.6	12.4	11.4	10.2	13.2	17.5	20.9	24.4	27.5	29.4	31.3	33.6	35.0	36.6	37.1	36.7	34.0	31.0	26.5	23.6	21.9	20.8	17.6
12	15.9	14.3	13.2	12.9	13.0	13.5	18.3	23.7	25.7	29.1	30.9	33.1	35.5	37.1	38.1	38.6	38.1	34.7	31.8	27.9	25.2	23.2	21.4	20.1
13	16.9	15.9	15.4	14.1	14.2	14.5	18.8	22.1	25.1	27.9	30.3	32.7	34.4	34.9	34.6	34.3	33.5	31.0	27.9	25.0	23.4	22.1	21.4	17.6
14	17.1	16.8	15.4	13.7	13.0	13.8	17.8	20.2	23.6	25.2	26.7	28.0	29.0	28.6	29.1	28.8	28.3	27.3	25.5	23.5	21.1	19.2	18.0	16.4
15	14.9	13.0	12.2	10.8	10.3	11.1	15.2	17.4	19.5	21.8	23.7	26.0	27.4	27.7	27.7	27.4	26.6	25.6	23.9	21.0	20.2	19.0	16.6	15.7
16	14.7	13.0	11.4	10.5	9.4	10.7	15.2	17.4	20.0	21.8	23.6	24.4	25.0	25.1	25.0	24.8	24.6	23.9	22.2	19.1	17.5	16.4	15.9	13.9
17	11.7	10.5	9.9	8.5	7.8	8.3	13.2	16.3	18.6	20.5	22.9	24.2	24.7	25.1	25.5	25.4	24.7	23.5	22.1	18.6	14.9	13.8	11.1	9.6
18	8.0	5.5	5.4	4.8	4.0	6.0	10.3	13.6	17.1	20.4	22.3	23.6	26.2	27.2	27.0	26.7	26.1	25.0	22.2	18.5	16.2	14.5	12.2	10.3
19	8.3	7.7	7.8	6.3	6.6	6.6	10.7	14.5	17.4	20.6	22.7	25.2	26.8	26.7	26.2	25.5	24.4	22.4	21.2	18.5	16.4	14.8	11.2	9.6
20	9.8	8.6	6.4	5.5	5.3	5.7	10.7	13.8	16.6	19.8	22.2	23.7	24.0	24.0	23.9	23.5	22.8	21.6	20.0	16.9	13.5	13.3	11.0	9.9
21	6.8	5.9	4.9	4.5	3.3	5.5	9.5	12.4	15.6	17.9	19.8	22.1	23.7	24.7	25.0	24.9	24.5	24.0	21.7	17.4	14.5	13.0	10.5	8.6
22	7.2	5.4	6.0	4.6	4.5	5.6	9.8	12.6	15.9	19.1	21.9	24.4	26.2	27.9	27.9	27.6	26.9	25.6	23.5	19.2	15.6	16.2	11.4	10.4
23	8.2	6.7	6.6	6.1	4.9	6.3	10.5	13.8	17.3	20.4	23.5	25.2	26.2	27.0	26.9	26.5	25.4	24.2	22.7	19.1	16.9	16.8	14.4	14.0
24	13.0	9.8	8.8	6.6	5.1	6.8	11.5	15.7	17.9	18.8	20.9	23.0	24.0	25.1	25.8	26.2	26.1	25.0	22.1	17.2	15.3	15.0	11.6	11.1
25	9.7	9.7	8.8	7.5	7.3	7.9	13.1	16.1	19.0	21.8	24.6	27.1	28.9	30.2	31.0	31.5	29.9	28.0	25.8	22.6	17.2	16.7	17.3	18.2
26	17.8	14.1	12.0	9.5	10.0	11.2	14.2	17.2	20.2	23.3	24.5	26.1	27.7	28.1	28.1	27.9	27.3	26.7	25.1	21.8	19.3	18.1	18.0	13.6
27	12.7	11.4	9.3	9.1	7.9	8.2	11.6	15.1	18.2	21.3	24.2	25.0	26.7	26.5	26.4	28.1	27.2	26.7	24.6	19.7	18.0	15.4	15.1	14.7
28	13.0	12.8	11.7	11.9	11.8	12.2	15.9	18.4	21.3	23.3	24.9	27.0	28.5	27.2	28.3	28.1	27.2	25.8	23.6	20.8	19.0	17.6	16.5	15.9
29	12.9	11.2	10.5	8.8	8.3	8.8	12.5	16.3	19.6	22.2	24.0	25.5	26.9	27.5	27.5	27.3	26.5	25.6	23.5	19.3	16.4	13.3	12.1	9.5
30	8.5	7.4	6.4	5.8	5.4	6.4	10.4	13.5	16.6	19.7	22.6	25.6	27.6	28.6	28.6	28.3	28.1	27.0	24.2	20.8	19.4	16.3	13.1	13.0

August, 1999 McArthur, CA for Hourly of Chilling at Fall River Nurseries, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	13.7	12.4	11.0	9.8	8.3	9.7	13.5	16.2	19.1	21.7	23.3	25.6	26.9	27.0	26.8	26.6	25.9	25.2	23.4	18.8	16.0	15.5	14.7	12.5
2	10.7	8.8	9.2	8.8	8.5	9.0	12.6	15.3	18.2	21.2	23.3	25.5	27.1	27.5	27.8	27.3	26.7	25.9	24.1	20.6	18.7	16.6	14.4	12.9
3	10.6	9.2	8.1	7.4	8.0	8.4	12.3	15.4	18.2	21.4	24.1	25.8	27.6	29.4	29.3	29.1	28.5	27.3	24.5	19.3	18.0	16.1	13.7	12.3
4	10.8	9.6	9.7	9.1	8.9	10.8	14.7	17.8	19.3	22.8	25.1	27.6	28.2	28.9	29.9	27.9	25.8	23.9	22.9	19.8	19.0	18.8	16.7	14.0
5	13.4	12.5	11.5	11.0	11.3	10.6	13.6	17.5	19.8	22.7	24.8	26.0	26.0	25.2	24.6	25.0	24.0	22.0	19.4	17.1	15.9	15.3	14.3	14.0
6	13.3	14.0	14.4	14.3	13.0	13.0	14.1	14.6	16.4	19.0	19.0	20.0	18.3	14.4	15.3	15.4	15.3	15.8	14.2	12.6	11.2	10.9	8.9	7.9
7	6.7	7.5	8.3	7.6	7.7	7.5	8.3	11.5	14.2	16.8	18.1	18.9	20.0	20.2	20.2	20.2	19.8	18.9	17.0	14.1	12.2	9.8	7.8	7.5
8	6.1	5.9	6.5	5.9	5.9	6.9	8.8	9.9	11.9	15.2	18.2	20.9	23.0	24.6	25.9	25.6	23.9	22.5	20.4	18.3	16.7	15.2	13.2	10.6
9	10.0	10.1	10.1	9.8	8.9	9.0	10.6	13.3	16.0	18.9	21.5	23.9	25.9	27.9	27.0	25.7	24.1	24.7	22.0	20.9	20.1	19.5	17.9	16.5
10	15.0	13.4	12.7	11.7	10.6	10.5	15.3	15.7	19.0	17.6	17.9	19.3	21.8	23.1	21.5	20.7	20.0	18.9	17.8	16.4	14.9	14.4	13.9	13.8
11	13.7	11.9	11.8	11.2	10.2	12.1	12.5	13.5	14.9	16.6	18.5	19.9	21.2	22.8	23.5	23.5	23.0	21.8	19.8	17.4	16.1	14.2	13.1	12.7
12	10.5	9.8	9.2	8.4	8.1	8.4	11.0	13.3	16.0	19.4	21.2	23.0	24.9	25.0	24.9	24.7	24.1	22.9	20.9	17.9	15.4	15.3	13.3	9.9
13	8.3	8.3	7.1	5.6	5.3	5.3	10.3	14.0	17.2	19.4	21.1	22.0	22.5	22.8	22.7	22.5	22.3	21.5	19.1	15.6	14.8	14.2	10.1	11.8
14	11.8	10.7	10.4	10.0	10.0	9.5	12.1	13.9	16.2	18.5	20.0	22.1	22.9	23.4	23.8	23.6	23.1	22.1	18.8	14.5	14.4	14.8	12.9	11.1
15	9.9	9.1	8.3	7.8	5.6	6.0	9.8	12.9	15.5	17.8	20.6	22.7	23.9	25.3	26.7	27.1	26.4	24.6	21.0	16.6	14.0	10.8	11.5	9.0
16	8.9	8.1	7.1	6.7	6.2	5.9	10.6	13.7	16.9	20.2	23.3	25.9	28.2	29.8	29.4	28.4	27.5	26.2	23.5	21.1	17.6	13.9	12.8	9.7
17	8.5	8.5	6.9	5.6	5.8	5.1	8.6	13.3	16.7	19.3	23.1	26.4	28.0	29.4	28.9	29.2	28.2	26.9	23.5	18.9	16.3	13.6	13.1	9.6
18	9.0	8.9	7.5	8.3	8.0	5.5	9.4	14.1	17.7	21.0	23.7	26.8	27.5	27.0	27.2	26.5	25.6	24.2	21.6	17.4	16.3	13.5	11.5	8.9
19	7.8	5.4	4.5	4.1	4.2	4.4	9.4	13.4	16.9	20.3	23.1	25.4	27.1	29.1	29.8	29.2	28.3	26.3	22.4	17.9	16.3	12.5	11.3	9.6
20	6.7	6.2	5.9	5.1	5.2	4.8	8.4	13.4	17.6	20.1	23.8	25.6	28.3	29.3	29.2	28.3	27.6	25.9	23.4	19.0	15.1	13.2	11.2	10.4
21	10.2	9.0	8.2	7.2	8.7	8.1	12.1	17.2	21.0	23.5	25.6	27.3	28.6	30.1	30.1	30.3	30.1	28.4	24.6	22.1	18.3	17.7	18.1	17.9
22	16.5	13.6	12.6	14.3	10.7	11.2	13.6	19.0	22.7	24.9	27.6	29.9	31.8	33.0	30.9	33.8	28.8	24.5	23.8	20.8	20.4	18.4	17.7	16.8
23	14.7	14.9	13.4	14.3	15.4	16.3	17.2	19.9	24.4	27.0	28.3	30.5	28.2	19.9	18.9	21.4	21.5	21.9	21.3	17.7	15.4	14.9	12.8	12.3
24	11.5	10.7	9.8	8.5	8.4	8.5	10.8	13.9	17.2	19.7	22.7	25.8	27.9	30.0	31.0	32.1	32.2	29.3	24.5	21.4	18.3	15.7	15.4	12.9
25	12.4	11.3	10.4	9.4	9.5	8.6	11.5	15.3	19.8	23.0	25.2	28.7	31.5	33.0	33.2	32.7	32.0	29.8	26.3	22.4	17.7	15.2	14.3	12.4
26	13.4	11.6	10.5	9.9	9.1	8.9	11.4	14.9	19.0	22.1	25.2	27.7	29.8	31.5	29.8	31.4	30.6	27.0	24.8	24.0	24.1	23.2	21.3	20.1
27	18.8	19.1	20.4	19.3	17.4	16.1	15.7	19.5	22.8	24.3	26.0	27.0	28.3	28.6	26.7	25.0	23.6	22.8	22.1	19.8	18.3	18.2	18.4	17.1
28	16.2	15.8	13.3	12.1	12.0	11.3	13.4	16.6	19.5	22.0	24.5	26.1	27.9	29.6	30.7	31.1	29.8	27.5	22.2	19.9	16.6	15.2	13.4	13.4
29	11.9	10.0	9.3	8.9	9.5	9.0	11.3	15.5	19.3	22.1	25.1	27.3	27.5	27.7	27.7	27.4	26.5	25.0	21.0	17.4	16.6	15.4	15.6	12.2
30	13.2	15.5	14.9	14.7	14.5	14.7	14.4	12.9	9.8	10.2	13.1	14.4	13.3		12.0	13.9	14.3	13.8	11.5	10.3	7.6	5.7	4.3	3.1
31	3.8	3.3	3.2	2.3	2.2	1.2	3.7	7.8	10.7	13.0	15.7	17.2	18.3	19.1	19.8	20.4	19.9	18.6	13.6	11.6	8.6	8.0	7.0	7.0

August hourly temperatures for Fall River Nursery in McArthur, CA 1999 (°C)

September hourly temperatures for Fall River Nursery in McArthur, CA 1999 (°C).

September, 1999 McArthur, CA for Hourly of Chilling at Fall River Nurseries, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	5.5	3.0	1.9	1.2	1.1	0.8	2.7	7.9	11.4	13.0	16.2	18.4	20.8	21.9	22.4	22.9	22.7	20.2	15.7	13.2	13.2	11.6	8.7	7.9
2	5.9	4.1	1.7	2.1	1.9	1.8	3.3	9.3	13.5	16.2	18.9	20.5	22.1	23.4	24.1	24.2	23.2	21.2	17.1	13.7	13.4	12.8	10.7	10.4
3	9.8	10.7	9.4	5.7	5.6	3.2	5.0	11.4	15.5	17.3	18.9	20.3	21.5	22.6	23.5	24.3	24.2	21.1	16.1	11.7	11.2	8.7	8.5	7.8
4	6.3	6.3	5.5	6.1	4.2	2.1	4.4	11.3	15.1	19.7	22.7	24.7	26.4	27.1	27.7	28.7	28.2	26.3	19.6	15.4	13.2	12.5	11.4	9.8
5	8.1	6.8	4.9	4.8	4.5	4.3	5.8	11.5	15.9	19.2	22.3	25.0	28.0	29.4	28.7	28.2	27.3	24.4	20.0	20.9	18.2	13.9	12.4	11.4
6	10.0	8.1	8.5	7.4	7.2	5.2	6.8	13.0	17.4	19.7	23.0	25.3	27.0	28.2	29.4	30.1	29.0	25.5	22.9	18.1	16.4	14.7	13.4	12.3
7	11.0	9.7	8.3	6.8	7.9	6.5	6.5	13.6	17.1	19.5	22.0	24.5	27.0	29.0	30.3	31.0	29.9	25.7	22.3	18.1	15.6	15.0	13.6	11.7
8	11.1	9.7	8.2	8.8	7.7	6.9	8.0	13.4	16.4	19.2	22.8	25.3	27.8	29.5	29.5	29.3	28.5	27.5	22.7	19.6	14.7	13.4	11.6	10.5
9	9.6	9.0	9.1	8.2	6.8	7.5	9.1	13.3	16.8	20.2	23.7	26.1	27.5	28.5	26.1	25.3	24.0	23.0	21.6	16.5	18.9	16.2	15.8	16.0
10	14.4	12.2	11.8	10.7	9.6	9.4	10.3	13.3	14.3	17.0	21.8	25.6	28.0	29.5	28.8	28.9	26.0	23.4	20.5	17.3	17.0	13.3	13.1	13.3
11	11.3	9.0	8.9	8.3	5.5	5.5	8.3	14.3	17.9	21.3	23.5	26.0	28.1	29.5	30.1	30.2	28.7	25.0	20.8	18.8	16.1	13.6	13.4	12.1
12	11.5	10.5	7.8	5.3	5.1	4.3	7.3	14.3	17.1	20.9	24.2	26.9	29.1	30.5	31.4	31.4	29.9	27.7	22.6	19.8	18.7	16.2	12.9	12.2
13	9.5	8.2	6.6	5.2	5.6	5.5	6.8	12.3	14.0	19.5	22.7	25.0	27.9	30.2	31.6	31.4	28.6	25.8	22.3	20.4	19.6	15.6	13.9	11.5
14	9.7	9.2	7.5	6.5	6.1	5.0	7.2	13.3	17.1	20.1	24.2	27.0	29.0	32.1	33.5	34.6	32.7	27.5	20.2	17.6	15.0	12.9	13.6	9.4
15	9.0	8.0	6.4	6.2	5.2	5.4	8.2	16.9	21.3	26.5	29.5	31.7	34.1	35.4	35.2	28.1	27.3	28.0	19.0	16.1	13.4	11.9	10.7	9.7
16	7.8	6.9	6.2	6.3	5.8	4.2	8.0	16.8	20.6	23.2	27.5	31.2	32.2	31.8	30.5	29.4	27.2	22.7	17.0	13.6	12.8	11.3	9.2	8.5
17	7.5	6.7	6.3	5.3	4.5	4.9	6.9	14.9	20.2	23.2	26.2	29.4	32.2	33.0	30.7	29.7	27.5	22.4	16.5	15.0	12.0	10.2	10.8	8.7
18	9.4	7.0	5.6	5.6	4.3	3.1	6.0	15.5	20.7	23.9	27.1	30.4	32.5	33.4	33.6	33.3	28.1	24.9	23.7	20.6	18.6	17.1	15.1	11.5
19	11.8	10.3	10.3	8.5	7.1	6.5	9.0	17.0	22.5	27.1	29.9	31.8	33.6	34.6	34.3	31.3	28.3	23.7	20.9	19.3	16.2	14.1	10.9	9.6
20	8.7	7.4	6.8	6.9	5.1	5.3	8.6	16.5	20.4	25.3	28.7	31.7	33.5	34.4	34.7	34.4	31.8	25.4	19.9	18.5	16.4	15.6	15.8	12.8
21	10.5	9.4	8.6	7.8	7.4	7.0	9.9	17.6	20.3	24.4	28.7	30.6	32.2	32.3	30.5	29.4	27.2	24.2	20.0	17.7	13.9	12.3	10.7	9.1
22	9.0	7.8	7.1	5.6	5.8	4.8	7.1	15.2	18.8	23.8	29.2	31.4	33.2	33.8	34.5	33.5	31.2	27.7	25.7	25.1	23.0	20.0	18.3	16.2
23	13.8	12.1	10.5	9.5	9.3	9.4	11.9	18.5	23.8	27.2	28.7	30.7	33.2	33.7	34.3	30.9	26.9	23.4	20.9	19.4	17.5	17.8	15.8	14.1
24	11.8	10.7	9.7	9.2	8.0	7.6	10.1	16.6	21.7	24.0	25.5	26.5	28.0	27.8	27.6	27.1	25.5	22.7	20.4	18.1	15.7	15.1	12.7	11.3
25	10.0	9.6	9.1	8.3	7.6	7.0	10.3	15.6	19.7	23.5	25.6	27.7	30.2	31.8	31.5	28.4	24.8	21.6	17.1	16.5	15.2	12.5	13.1	11.1
26	9.9	7.4	5.3	4.7	3.1	3.9	7.1	11.6	15.7	17.8	21.1	23.9	25.1	26.8	24.2	22.8	21.0	17.0	11.6	11.3	9.0	7.8	7.8	9.9
27	11.1	8.1	4.6	4.1	4.4	2.0	5.8	12.4	14.5	15.7	19.8	21.3	23.5	21.9	21.6	21.3	19.4	17.2	13.1	10.6	10.0	7.1	7.2	4.8
28	3.8	3.9	4.8	3.9	3.7	3.2	6.8	13.1	15.9	18.0	19.9	21.5	23.2	24.0	23.9	23.0	21.8	18.9	12.1	9.4	7.9	5.7	6.1	5.9
29	4.6	3.0	1.9	0.9	0.7	-0.4	1.6	8.6	14.7	19.7	21.9	25.3	27.7	27.7	25.9	24.2	21.1	16.0	12.9	10.4	8.7	7.2	6.8	4.8
30	4.8	4.1	2.7	2.9	2.1	1.1	2.0	7.0	13.4	17.9	21.7	24.7	28.3	29.8	29.8	26.2	23.9	18.5	14.5	13.3	9.9	8.1	7.0	5.1

October hourly temperatures for Fall River Nursery in McArthur, CA 1999 (°C)

October, 1999 McArthur, CA for Hourly of Chilling at Fall River Nurseries, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	4.8	4.6	4.2	3.6	2.6	2.0	2.6	8.6	15.3	19.8	24.3	26.5	28.3	29.7	29.1	28.6	24.7	16.2	12.6	10.6	8.6	7.3	5.7	4.5
2	3.8	3.2	4.1	1.5	0.9	0.9	1.0	8.6	15.2	18.5	21.9	24.6	28.2	30.0	29.6	29.5	27.5	19.5	15.5	13.7	9.6	8.3	6.5	5.8
3	5.6	4.7	4.0	3.5	2.9	0.8	1.9	8.9	15.0	18.3	21.9	25.8	28.8	30.6	28.7	25.9	22.8	19.5	16.0	13.9	14.2	9.6	8.4	6.2
4	5.6	4.8	3.7	2.5	3.0	2.0	2.5	8.2	14.6	18.2	23.0	25.4	26.7	24.8	23.8	22.7	20.7	18.2	16.6	14.9	14.0	13.3	11.9	10.2
5	9.6	6.8	4.8	3.6	3.4	3.7	2.4	9.1	15.9	17.7	18.6	19.7	18.8	18.1	17.6	15.6	13.4	12.3	11.1	11.2	10.5	10.1	10.1	9.3
6	8.1	8.0	8.4	8.5	8.7	8.5	8.4	8.9	9.7	10.8	9.9	9.0	11.7	14.2	16.5	15.3	17.0	11.8	9.8	7.4	5.9	5.5	4.6	3.4
7									Plants Harvested															
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August hourly temperatures for La Ronge, Saskatchewan (0.1°C) 1999.

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	106	106	107	106	107	107	109	115	125	134	140	143	150	140	133	157	166	180	165	182	178	150	116	107
2	115	122	124	123	125	127	129	135	143	158	181	194	201	211	212	211	216	214	210	218	207	182	162	152
3	148	142	138	144	152	144	135	144	161	168	179	193	220	239	254	265	266	271	268	264	248	221	174	181
4	166	138	130	138	126	110	110	145	180	218	238	252	260	268	276	279	263	265	261	260	240	232	219	214
5	196	175	166	175	180	174	166	176	178	190	194	207	217	201	226	235	243	246	238	226	207	201	194	184
6	182	177	166	169	171	164	164	169	175	173	176	181	190	182	175	178	159	161	171	168	160	144	130	124
7	90	94	59	61	44	34	45	83	120	140	149	159	170	182	198	200	192	196	196	192	179	172	169	167
8	161	156	142	143	147	148	144	151	164	175	186	193	207	201	200	190	190	196	193	184	180	177	174	172
9	165	162	158		154	152	152	156	150	146	145	149	162	168	175	184	177	182	170	157	143	137	110	102
10	76	68	68	87	77	73	75	109	119	126	135	159	164	171	173	170	167	175	169	162	151	138	118	109
11	83	92	90	66	88	84	77	80	102	154	164	162	171	170	177	182	178	200	183	179	170	156	142	132
12	127	105	83	78	65	49	70	102	140	157	167	163	171	181	172	199	202	195	196	183	167	140	113	99
13	90	83	77	67	64	66	77	106	138	173	188	202	205	215	226	231	232	224	228	210	199	176	166	154
14	145	130	123	118	115	97	86	119	165	178	196	217	227	232	243	246	252	263	258	241	225	204	189	184
15	161	158	164	157	159	152	160	157	170	180	189	182	184	164	177	186	182	184	181	180	171	167	161	156
16	154	153	153	137	137	138	134	135	142	144	160	164	172	177	180	185	187	189	189	188	183	178	161	153
17	146	148	160	156	152	152	153	152	160	175	182	198	204	219	205	204	218	224	225	220	204	186	171	172
18	168	177	179	174	175	169	166	176	196	214	228	236	253	270	278	272	271	258	263	258	246	218	202	196
19	197	192	182	178	174	166	166	186	206	225	246	264	276	294	302	302	302	303	294	259	265	240	226	215
20	185	174	179	192	189	166	172	182	204	232	261	272	280	296	299	307	314	315	310	283	272	248	237	214
21	217	212	196	201	186	166	157	151	200	223	238	249	261	268	274	283	282	279	269	264	241	239	220	204
22	190	183	172	190	182	173	180	172	164	164	170	176	196	213	212	226	235	243	217	203	195	186	179	175
23	178	172	168	157	155	146	139	147	166	194	207	226	238	253	256	257	264	266	262	250	232	208	205	188
24	178	174	164	152	166	146	140	150	181	200	219	232	251	266	262	267	269	268	267	260	232	221	214	207
25	201	194	187	179	177	169	162	182	189	196	218	245	266	287	315	305	297	295	232	163	164	161	158	150
26	147	154	153	146	142	138	136	141	151	158	168	178	186	197	205	204	204	199	196	196	182	170	164	160
27	159	150	146	143	137	131	128	128	136	147	156	161	173	180	187	194	188	187	183	174	155	119	91	73
28	68	56	46	45	33	38	21	48	104	137	146	149	152	166	177	190	191	196	191	182	166	151	164	156
29	152	147	142	138	136	128	130	137	149	165	182	204	228	238	245	245	242	225	216	210	201	193	192	189
30	189	186	183	180	177	165	164	161	166	175	193	206	234	230	248	259	257	247	232	213	204	200	188	171
31	175	172	173	163	157	159	161	157	157	153	150	138	135	128	129	128	118	115	113	113	106	106	105	102

September hourly temperatures for La Ronge, Saskatchewan (0.1°C) 1999.

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	102	101	97	93	83	69°	61°	59°	57°	61°	69	79	89	98	112	116	111	106	99	98	91	82	80	77
2	77	73	75	73	58°	56°	56°	44°	.92	102	124	134	144	150	161	172	160	166	157	150	130	121	107	97
3	96	87	83	74	82	73	76	90	109	131	153	160	190	196	189	200	183	177	193	161	130	102	84	77
4	77	63°	71	71	69°	51°	49°	53°	89	131	155	171	177	200	202	186	178	176	171	170	158	149	155	149
5	144	141	135	129	125	129	120	114	125	149	171	183	186	186	190	198	196	196	192	178	154	148	141	140
6	138	134	128	127	123	118	113	113	100	94	92	106	118	128	132	135	128	135	133	137	132	127	120	123
7	122	120	119	117	121	120	119	118	110	108	109	111	108	109	109	105	100	93	90	90	76°	64°	58°	59°
8	57°	63°	64°	66°	69°	61°	57°	62°	74	91	119	117	130	129	133	137	138	146	137	128	109	104	89	95
9	75	56°	67°	59°	57°	57°	45°	54°	80	99	123	145	148	159	166	169	176	183	166	145	116	84	68°	58°
10	44°	27°	31°	61°	66°	62°	47°	77	101	113	121	124	129	142	143	148	166	147	141	145	131	113	125	122
11	102	104	99	97	90	97	84	82	98	119	125	131	119	128	131	118	121	124	122	113	105	96	92	91
12	86	84	82	81	74	72	62°	53°	69°	84	91	103	114	107	120	110	122	98	99	93	90	79	74	65°
13	69°	76	77	79	81	79	75	68°	73	77	90	105	106	112	105	106	110	107	103	97	68°	51°	25°	13°
14	3°	3°	-3	-9	-11	-3	-14	-8	39°	76	112	134	148	156	161	166	173	171	166	149	129	121	109	93
15	88	85	80	71	75	71	69°	69°	109	135	156	171	192	202	217	225	228	230	215	190	147	122	109	110
16	132	146	135	130	120	110	109	104	113	126	135	149	153	168	181	198	198	194	182	183	179	176	164	158
17	151	144	139	147	139	132	133	136	126	121	123	128	145	151	160	161	176	145	142	121	112	98	101	101
18	81	78	75	74	73	72	73	72	77	67°	58°	51°	58°	62°	71	77	74	67°	64°	64°	62°	59°	56°	55°
19	48°	44°	41°	39°	37°	28°	39°	35°	41°	52°	57°	68°	85	84	81	83	89	89	86	83	83	79	69°	64°
20	62°	60°	56°	48°	45°	41°	42°	49°	61°	87	138	162	186	213	225	228	230	231	228	201	186	175	166	165
21	149	136	124	112	94	84	74	66°	92	107	136	158	174	186	199	204	199	189	182	160	137	138	127	136
22	140	139	125	114	93	83	61°	48°	54°	103	124	144	168	181	182	177	174	173	165	144	92	72	58°	51°
23	34°	19°	24°	14°	11°	22°	79	93	103	109	120	139	149	171	189	194	191	199	192	174	167	168	159	160
24	150	131	135	115	120	130	130	131	134	105	97	95	96	90	95	98	102	104	112	101	85	59°	79	72
25	78	73	70	70°	62°	66°	60°	47°	61°	98	102	116	131	146	149	140	136	133	139	111	89	75	76	54°
26	55°	51°	50°	32°	27°	-4	-6	-10	37°	65°	79	83	92	93	100	92	87	83	81	74	71°	67°	58°	41°
27	34°	11°	-5	-11	-7	0°	0°	16°	28°	47°	62°	87	93	98	87	104	110	119	109	92	88	77	66°	61°
28	56°	55°	57°	46°	36°	34°	28°	15°	15°	22°	32°	46°	53°	59°	63°	72	79	77	67°	56°	62°	56°	55°	65°
29	49°	58°	55°	60°	68°	64°	56°	51°	56°	56°	62°	62°	61°	62°	57°	63°	54°	44°	34°	41°	37°	21°	12°	8°
30	1	-1	0	-2	-6	-11	-18	-11	-17	-15	-9	0°	11°	13°	19°	19°	16°	13°	14°	9°	6°	8°	1°	0°

August hourly temperatures for Outlook, Saskatchewan (0.1°C) 1999.

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	92	79	80	76	72	65	78	85	107	132	154	168	176	175	176	192	197	196	199	196	173	158	135	118
2	102	103	96	81	76	72	71	97	134	164	186	203	209	217	218	217	227	219	218	221	198	179	154	134
3	120	113	103	97	107	119	121	137	165	186	208	223	232						259	254	231	201	181	160
4	154	136	140	135	133	132	136	152	180	202	227	249	263	272	282	290	290	286	282	269	252	231	207	179
5	174	160	140	135	127	123	122	151	184	212	236	258	272	282	282	288	287	287	286	277	254	204	195	201
6	185	183	178	173	176	165	158	160	167	184	190	201	218	217	223	236	214	223	202	173	182	163	151	140
7	130	124	119	112	108	103	102	111	128	147	153	166	179	190	196	202	203	195	190	187	180	168	157	150
8	148	138	142	151	156	154	151	153	157	165	189	223	248	253	258	270	273	271	269	255	233	197	187	183
9	175	167	171	172	151	144	148	156	168	190	200	213	216	221	231	231	232	229	233	229	217	197	182	177
10	155	140	132	119	117	106	114	114	117	117	123	137	154	150	156	186	181	157	160	148	143	136	131	117
11	125	116	121	115	109	103	98	102	125	142	153	175	179	194	201	201	205	206	200	186	173	157	160	154
12	147	124	117	114	107	103	105	115	144	165	174	191	200	198	202	205	218	212	198	187	173	158	148	147
13	144	143	138	133	134	132	133	135	146	161	186	190		212	217	215	219	208	194	196	188	163	153	134
14	129	126	126	123	122	116	115	132	138	150				205	216	233	236	229	218	213	200	174	164	155
15	133	132	121	115	117	108	96	122	154	173	191	197	199	209	204	212	202	184	170	158	151	148		
16		141	142	144	141	139	131	133	138	145	154	163	171	182	203	213	212	219	203	152	155	140	130	125
17	128	138	140	138	130	124	124	125	130	143	152	161	167	171	183	195	202	212	211	210	190	158	135	129
18	117	118	114	109	106	103	95	112						252	256	261	263	257	252	241	210	170	150	156
19	140	139	122	126	128	117	109	133	142	163	191	225	255	274	277	287	275	264	244	230	225	209	210	201
20	199	198	184	179	177	158	141	142	179	200	229	254	278	289	289	298	302	311	306	291	246	213	186	176
21	167	165	157	158	154	142	135	143	188	208	238	264	282	294	310	314	320	320	317	282	252	225	205	199
22	192	176	164	152	149	148	139	139	139	151	168	174	160	156	136	159	185	211	219	215	187	174	143	141
23	142	136	128	122	117	109	104	117	140	170	196	219	234	242	256	266	270	264	254	235	200	162	147	146
24	167	162	148	152	148	136	123	138	169	188	217	256	272	293	304	315	316	319	311	286	260	237	204	180
25	159	152	145	158	152	184	200	182	203	252	277	291	308	317	320	320	322	315	301	276	232	200	185	167
26	160	151	161	147	130	128	120	121	145	173	186	200	214	224	231	241	244	245	240	230	207	189	171	135
27	110	105	92	88	87	92	73	87	130	173	202	223	237	248	255	265	270	267	256	234	203	171	155	136
28	128	115	108	106	99	93	88	94	130	168	190	207	221	231	241	249	250	249	243	224	198	182	176	164
29	150	147	146	142	141	137	137	133	145	160	161	150	149	166	188	182	211	201	203	189	181	174	169	161
30	162	162	163	161	162	166	163	162	173	201	239	268	289	305	323	323	329	327	318	301	272	264	244	228
31	232	234	238	223	217	192	176	135	129	137	145	149	140	134	146	176	191	199	196	186	153	131	111	93

September hourly temperatures for Outlook, Saskatchewan (0.1°C) 1999.

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	102	101	97	93	83	**69***	**61***	**59***	**57***	**61***	69	79	89	98	112	116	111	106	99	98	91	82	80	77
2	77	73	75	73	**55***	**56***	**55***	**44***	82	102	124	134	144	150	161	172	160	166	157	150	130	121	107	97
3	96	87	83	74	82	73	76	90	109	131	153	180	190	196	189	200	183	177	193	161	130	102	84	77
4	77	**63***	71	71	**68***	**51***	**40***	**53***	88	131	155	171	177	200	202	186	178	176	171	170	158	148	155	149
5	144	141	135	129	125	129	120	114	125	149	171	183	186	186	190	198	196	196	192	176	154	148	141	140
6	138	134	128	127	123	118	113	113	100	94	92	106	118	128	132	135	128	135	133	137	132	127	120	123
7	122	120	119	117	121	120	119	116	110	108	109	111	108	109	109	105	100	93	90	80	**70***	**64***	**58***	**59***
8	**57***	**63***	**64***	**66***	**69***	**61***	**57***	**62***	74	91	119	117	130	129	133	137	138	146	137	128	109	104	89	85
9	79	**55***	**67***	**59***	**57***	**57***	**45***	**54***	80	99	123	145	148	159	166	169	176	183	166	145	116	84	**68***	**58***
10	**44***	**27***	**31***	**61***	**66***	**62***	**47***	77	101	113	121	124	129	142	143	148	166	147	141	145	131	113	125	122
11	102	104	99	97	90	97	84	82	98	119	125	131	119	128	131	118	121	124	122	113	105	96	92	91
12	86	84	82	81	74	72	**62***	**53***	**69***	84	91	103	114	107	120	110	122	98	99	93	80	79	74	**65***
13	**69***	76	77	78	81	79	75	**60***	73	77	90	105	106	112	105	106	110	107	103	97	**68***	**51***	**25***	**13***
14	**3***	**3***	-3	-9	-11	-3	-14	-8	**39***	76	112	134	148	156	161	166	173	171	166	149	129	121	109	93
15	88	85	80	71	75	71	**69***	**69***	109	135	156	171	192	202	217	225	228	230	215	190	147	122	109	110
16	132	146	135	130	120	110	108	104	113	126	136	148	153	166	181	196	198	194	182	183	179	176	164	158
17	151	144	138	147	138	132	133	136	126	121	123	128	145	151	160	161	176	145	142	121	112	98	101	101
18	81	78	75	74	73	72	73	72	77	**67***	**58***	**51***	**58***	**62***	71	77	74	**67***	**64***	**64***	**62***	**58***	**56***	**55***
19	**48***	**44***	**41***	**38***	**37***	**28***	**30***	**35***	**41***	**52***	**57***	**68***	85	84	81	83	88	88	86	83	83	78	**69***	**64***
20	**62***	**60***	**56***	**48***	**45***	**41***	**42***	**49***	**61***	87	138	162	186	213	225	228	230	231	226	201	186	175	166	165
21	146	136	124	112	94	84	74	**66***	82	107	135	158	174	186	198	204	199	188	182	160	137	138	127	136
22	140	139	125	114	99	83	**61***	**40***	**54***	103	124	144	168	181	182	177	174	173	165	144	92	72	**50***	**51***
23	**34***	**19***	**24***	**14***	**11***	**22***	79	93	103	109	120	139	149	171	189	194	191	190	192	174	167	166	159	160
24	150	131	135	115	120	130	130	131	134	105	97	95	96	90	95	98	102	104	112	101	85	**59***	79	72
25	78	73	70	**70***	**62***	**55***	**50***	**47***	**61***	88	102	115	131	146	148	140	136	133	139	111	88	75	76	**54***
26	**55***	**51***	**50***	**32***	**27***	-4	-6	-10	**37***	**65***	79	83	92	93	100	92	87	83	81	74	**71***	**67***	**58***	**41***
27	**34***	**11***	-5	-11	-7	**0***	**0***	**15***	**28***	**47***	**62***	87	93	88	87	104	110	119	109	92	88	77	**65***	**61***
28	**56***	**55***	**57***	**46***	**36***	**34***	**20***	**15***	**15***	**22***	**32***	**46***	**53***	**59***	**63***	72	79	77	**67***	**56***	**62***	**56***	**55***	**65***
29	**49***	**58***	**55***	**68***	**60***	**64***	**56***	**51***	**56***	**56***	**62***	**62***	**61***	**62***	**57***	**63***	**54***	**44***	**34***	**41***	**37***	**21***	**12***	**8***
30	1	-1	0	-2	-6	-11	-18	-11	-17	-15	-9	**0***	**11***	**13***	**19***	**19***	**16***	**13***	**14***	**9***	**6***	**8***	**1***	**0***

August hourly temperatures for Ile a la Crosse, Saskatchewan (0.1°C) 1999.

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	11.6	11.6	11.5	11.3	11.4	11	10.6	10.6	12.1	13.3	15.7	16.7	18.9	18.8	17.9	19.1	18.9	20	19.7	19.1	18.6	15.7	13.1	12.1
2	13	12.8	12.8	12.5	12.5	12.4	12.1	12.7	13.6	15.7	18.6	20.4	21.9	23.1	21.4	22.3	21.9	23.4	23.4	22.7	22	18.7	16.8	15.5
3	14.6	14.4	14.1	13.6	12.9	14	14.4	15.1	16.8	17.6	21	23.3	25.3	27	28	29.2	29	29	28.3	26.8	24.1	21.3	19.8	18.1
4	17.7	16.7	15.6	14.5	13.1	12.6	12.3	13.8	17.9	22.4	22.6	24.3	29	30.8	28.5	27.6	28.3	30.4	31.5	28.9	27.1	25.4	23.5	21.5
5	19.2	19.2	17.1	18.5	17.9	15.3	14.4	16.9	19.5	20.2	22.6	25.4	27.5	28.4	28	28.2	26.3	28.7	27	26.1	24.1	23.1	21.9	21.1
6	19.3	17.9	17.4	16	14.9	14.5	14.5	14.9	15.9	16.5	18.3	21.3	22.2	20.3	20.5	20.8	20.7	20.8	20.4	18.6	17.7	16.6	15.4	13.7
7	13.7	12.9	11.2	10.7	9.9	11.3	11.3	11.6	13.3	15.2	15.1	14.8	17.5	19.7	22.9	20.7	19.7	21.2	19.7	19.3	18	17.1	17.1	16.8
8	15.5	15.2	15.7	15.8	15.6	14.8	14.7	15.1	16	17.3	18.8	21.8	22.3	24	27	26.1	27.7	27.5	24.8	23.1	20.6	17.4	16.8	16.9
9	16.7	16.5	16.3	16.3	16.1	15.5	14.2	13.2	13.7	12.5	12.4	11.8	11.9	12.7	13.5	15.2	15.8	16.3	16.5	16.2	15.1	14.2	13.6	13.1
10	12.2	7.8	8.2	7.4	7.7	7.4	7.9	9	10.7	13.7	16	17.1	18.8	17.9	19	18.5	18.5	17.9	17.2	16.8	16.2	15.5	15.5	15.2
11	12.8	11.5	12.2	11.8	11.5	11.1	10.8	11	13.1	15.6	16	16.4	17.9	18.6	18.2	18.1	18.9	18	18	17.9	17.6	15.7	13.7	11.1
12	10.1	9	9	7.8	7.9	7.8	7.2	8.1	12	13.9	15.8	16.6	19.1	18.6	21.1	21.2	22.3	21.4	21.3	20	18.4	15.2	12.8	10.6
13	10	9.1	8.5	8.8	8.7	8.5	8.4	11.4	12.9	16.3	19	21.7	22.5	23.5	26	25.1	25.3	23.1	25.3	23	21.5	20.2	19.6	18.5
14	17.4	16.5	15.4	15.4	14.6	13.8	13.6	13.9	15.6	18.4	19.9	21.9	24.2	25.9	24.9	24.3	26.2	26.1	25.5	24.3	24.8	22.1	20.6	19.9
15	18.3	16.3	15.3	15.5	14.8	14.4	14.5	15.3	15.7	17.6	20	22.9	24.2	22.6	21.7	23.2	20.9	20.8	18.7	18.1	17.1	16.7	16.7	16.3
16	16.2	16.1	15.8	15.7	15.6	15.4	15.2	15.2	15.1	15.5	16.8	16.8	17.7	19.1	20.1	19.2	18.9	19	19.1	19.1	18.6	16.9	16.1	16.1
17	15.2	14.8	14.5	14.2	13.5	14	14.1	13.7	14.6	16.8	18.9	21.4	23.2	24.6	26.3	26.2	26.8	25.8	22.3	23.8	23	21.5	20.9	19.7
18	17.5	16.4	15.6	15.9	15.1	15.4	15.3	15.6	17.9	19.8	22.2	24.6	26.3	28.1	27.7	28.3	29	27.1	28.6	28	25.8	22.1	19.5	18.4
19	17.8	17.5	17	16.4	15.8	14.1	15.1	16.4	18.5	20.8	23	26.3	28.6	28.4	29.6	29.9	27.7	27.1	26.1	24.6	24	22.1	20.5	18.8
20	19.7	18.1	16.1	17.6	16.5	15.3	16.4	17	18.3	20.6	22.6	26.3	27.9	29.2	30.5	32.5	33.1	32.6	31.8	29.2	26.2	23.9	22.1	20.8
21	18.9	19	19.5	16.6	16	14.7	14.4	14.1	18.1	20.7	23.6	27.4	31.5	30.4	33.4	33.6	34.5	32.8	32	30.1	25.1	23.1	22.4	21.6
22	20.7	20.2	18.1	16	16.1	15.8	16.3	16	16.1	16.4	18.7	18.5	18.3	17.9	17.5	18.4	18.6	18.9	17.8	18	18.2	17.6	16.9	15
23	14.2	13.3	13.6	13.4	12.8	12.1	12.1	12.4	13.3	15.8	18.5	21.2	23.1	24.3	24.9	25.8	26	26.6	25.6	24.8	23.5	22.5	20.8	19.8
24	19.3	18.6	17.1	15.6	14.2	14.4	13.6	13.3	16.5	18.8	21.5	23	23.7	24.4	25.5	26	26.8	27.7	26	23.5	22.6	21.3	20.5	20.3
25	19.4	18.8	18.2	17.5	16.8	16.6	15.6	15.3	17.4	20.3	22.8	25.3	24.8	24.2	24.4	23	19.1	16.6	17.3	17.4	16.5	15.6	14.4	14.7
26	14.6	14	13.3	13.1	12.9	12.1	11.9	11.8	13.1	14.3	15.7	17.2	18.2	18.4	19.5	20	20	20.3	20	19	17.7	16.2	15.3	13.6
27	13.8	12.8	12.1	11.6	10.6	9	9.2	9.6	11.4	13.4	15	16.9	18.4	20	20.6	21.2	21.6	21.4	19.9	18.4	16.4	12.2	10.1	8.5
28	6.8	12.8	11.9	10	9	9	8.9	9.7	12	13.8	15.6	18.7	20.5	22.1	23.1	25.2	25.8	25.3	23.8	21.6	19.6	17.8	16.7	16.2
29	16.2	15.6	16.3	16	15.8	15.7	15.8	15.4	16.6	18.3	19.5	21.6	23.6	24.4	25.4	26	25	23.7	21.9	19.6	18.3	18.3	18.5	18.3
30	18.5	18.6	18.3	18.1	17.6	17.3	17.2	16.9	17.4	17.7	18.6	19.6	20.8	21	21.9	23.1	23.1	22.7	23.9	21.3	19.8	19	17.9	15.4
31	12.5	11.6	11	11.2	10.9	11	10.8	10.8	11.1	11.6	11.3	11.6	12.2	11.8	11.6	11.2	11	10.8	10.4	9.7	9.6	8.7	8.1	7.7

September hourly temperatures for Ile a la Crosse, Saskatchewan (°C)

Date	HR00	HR01	HR02	HR03	HR04	HR05	HR06	HR07	HR08	HR09	HR10	HR11	HR12	HR13	HR14	HR15	HR16	HR17	HR18	HR19	HR20	HR21	HR22	HR23
1	7	7	6.9	7	6.8	6.7	MISG	6.7	MISG	6.7	7.2	7.7	8.9	8.4	8.4	8.2	9.2	9.5	MISG	7.7	7.4	5.7	6.1	5.9
2	5.3	4.8	3	3.8	4.6	4.6	3.6	3.9	5.6	8.3	12.3	14	15.8	16	17.5	17.3	18.4	16.7	13.3	12	10.8	10.9	8.4	11.9
3	MISG	7.9	6.9	7.1	7.1	5.5	5.3	5.5	9.5	12.3	13.3	15.7	17	18.2	18.9	19.7	19.3	19.1	16.7	14.7	13.2	10.9	10.6	11.6
4	10.9	9.5	8.9	8.4	8.4	7.8	8.2	8.1	9.8	11.8	14.6	17.4	17.9	19	19	20.3	20.2	20	19	17.7	15.9	14.7	13.7	12.6
5	11	10	9.1	8.3	8.8	7.7	MISG	8.1	10.3	13	16.1	17.5	18.5	19.2	18.4	19.6	19.9	18.8	18.1	17.3	16.1	14.4	14	14
6	13.6	13.5	13.5	13.5	12.9	12.6	12.6	12.3	11.1	10.5	10.4	10.5	10.3	9.9	10	9.4	9.2	9.1	8.9	8.3	7.8	7.8	7.5	7.9
7	7.9	8.1	8.2	8.5	8.8	8.8	8.9	9.4	9.4	9.3	9.3	9.1	9.6	9.9	11	10.7	11.6	11.3	10.1	9.5	9.7	8.4	4.2	7.3
8	6.7	6.7	6.9	7	6.7	6.5	6.2	6.6	8.3	9.5	10.6	10.2	11.6	12.7	14.2	14.3	15.8	15.2	15.3	13.8	11.2	9.3	7.3	8
9	6.1	5.7	5.7	4.1	4.1	2.8	3.6	4.4	5.9	10	12	14.4	15.9	16.7	17.4	18.2	18.5	18.3	17.6	15.7	13.6	12.6	12.8	11.9
10	11	11	10.9	10.5	10.2	9.6	9.6	9.2	9.8	10.5	13.2	14.1	13.7	13.6	12.9	12.4	11.9	12.5	11.7	11.6	11.5	11	10.7	10.4
11	10.3	10.9	10.6	9.6	9.7	9.7	8.8	9.1	8.5	8.3	9.3	10.3	10.3	9.8	9.7	9	8.2	7.7	7.3	7.4	7.5	7.4	7.1	6.9
12	6.6	5.4	6.6	6.2	2.2	4.8	MISG	4.2	5.5	7	8.3	9.2	9.8	10	11.6	11.7	11.6	11.9	10.6	9.9	9.3	9.2	5.7	8.2
13	3.9	4.6	3.5	4.1	4.7	2.7	3.7	5.3	6.6	MISG	8.7	9.2	9.9	10.2	11.4	12.2	12.4	13.2	12.8	9.6	MISG	MISG	5.3	5.7
14	5.4	3.8	3.1	2.5	2.6	3.1	3.1	3.3	4.6	7.9	11.3	13.9	16.6	18.3	19.9	20.5	21.2	21.4	20.4	18.2	16	14.9	14.7	14
15	13	10.9	9.9	9.3	8.5	8.7	8.3	7.9	8.3	13	14	15.9	17.7	18.6	19.8	20	20.1	20	18.4	15.7	13.6	15.2	14.9	13.4
16	12.2	12.2	11.9	11.5	10.9	10.5	10	10	10.5	11.7	13.1	15.2	16.6	19.2	19.9	20.7	21	20.1	19.5	18.7	17.1	16	15	13.5
17	13	14.4	13.3	13.3	12.1	10.9	10	9	9.4	9.8	11.7	13.3	14.2	15.1	13.8	12.1	12.8	11.9	11.1	9.4	7.3	7.9	8.1	7.5
18	7	7.1	6.9	6.2	6	6.2	6.3	6.6	6.3	6.5	6.4	5.9	6.3	6.6	7.2	6.9	7.1	7.1	7.1	6	5.9	6.4	5.8	6.2
19	5.9	5.6	5	5.3	4.6	4.5	4.7	4.6	4.9	5.5	7	8.4	9.4	10.8	12.2	13.1	13.8	13.8	12.9	11.7	10.8	9.7	5.7	8.4
20	8.1	7.5	7.4	7.2	7.2	6.7	7	7.3	8.1	10.8	13.7	16.6	19.2	22.1	23.6	24.7	24.1	22.5	20.9	19.3	18.4	16.9	15.8	13.6
21	12.9	11.8	10.4	9.6	9.2	8.6	8.6	8.4	9.4	11.2	12.7	14.6	15.7	17	18.3	20.2	20.6	20	17.6	16.1	15.2	14.3	12	11.9
22	11.9	10.6	10.8	9.7	9.1	7.6	5.3	8.3	8	10.2	12.6	13.5	15	16.5	16.8	16.9	17.8	17.6	15.1	11.6	9.6	10.6	9.8	10.8
23	9.9	9.8	11.1	11.6	11.5	11.4	11.8	11.7	12.3	13.8	15.4	15.3	16	17	18.9	19.4	19.5	18.3	15.9	14.5	12.6	12	14	14.5
24	14.3	14.1	13.3	11.9	11.4	10.4	10.1	9.8	9.6	9.4	9.2	9.7	10.1	10.9	13.8	14.7	15.1	14.8	13.7	12	11.3	11	9.7	8.9
25	8.6	8.3	7	7.3	6.5	5.9	5.9	5.5	6.2	6.4	7.3	9.4	11.2	12.8	13.8	14.6	13.1	13	10.8	8.6	7.5	8.1	7.8	7.8
26	7.2	7.1	6.1	5.9	5.7	6.7	6.3	5.7	5.2	5	6.8	6.7	7.4	8.3	8.4	9.7	8.6	9.7	7.9	7	6.4	5.7	3	2.5
27	0	0	7	1.1	7	1.4	7	5	3.3	3.4	5.9	7.7	9.2	10.5	11.3	8	8.8	5.8	6.3	5.5	4.8	4.7	3.8	2.9
28	2.4	1.7	1.6	1.6	1.5	2.5	1.1	1.3	1.6	3.7	3.9	5.1	7	8.2	8.9	9.1	10	9.6	8.4	7.1	6.5	6.6	6.3	6.1
29	6.2	7.2	7	6.4	6	6	4.8	5.1	4.7	6.4	7.2	6.4	6.8	6.5	5.1	4.9	4.2	2.8	2.2	2.2	1.8	1.3	0.8	0.8
30	4	1	0	-1.2	-1.9	-2.2	-2.4	-2.2	-2.7	-1.8	-5	5	1.1	1	1.8	2	2.2	2.3	1.4	1	0.7	0.6	-1	-1

August hourly temperatures for Lassen Canyon Nursery in Redding, CA 1999

August, 1999 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	17.3	15.6	14.4	13.3	12.9	13.2	15.8	18.2	20.3	22.5	24.8	26.4	27.9	28.4	29.1	29.3	29.2	28.4	27.2	23.9	20.8	20.9	19.1	18.9
2	19.2	16.7	17.5	16.2	15.3	15.2	18.5	21.0	24.0	26.1	27.8	29.1	30.0	30.6	31.1	31.2	31.3	30.3	28.1	24.0	22.3	21.3	20.4	19.6
3	18.9	18.1	18.7	16.9	16.3	16.4	20.4	23.5	26.0	28.2	29.9	31.4	32.3	32.9	33.1	33.0	32.6	31.7	28.7	24.8	22.0	21.4	21.1	20.4
4	18.9	18.7	18.3	17.4	17.2	16.3	19.1	20.3	25.0	26.6	28.4	30.0	31.1	31.6	31.9	32.1	31.5	30.6	29.1	25.7	23.6	22.7	23.0	21.7
5	19.8	17.4	15.9	14.6	13.6	13.6	16.2	16.9	18.5	20.7	23.0	24.2	24.1	24.6	25.0	25.1	24.9	24.6	23.4	21.7	20.7	20.1	18.7	17.2
6	17.2	17.1	16.8	15.6	14.8	15.6	15.9	16.5	17.6	18.3	19.8	20.1	21.1	20.6	22.6	23.5	23.5	21.3	19.9	17.8	16.7	15.2	14.7	14.5
7	14.6	13.2	12.7	13.8	13.6	13.6	15.7	17.1	19.7	21.4	23.0	24.6	25.1	25.6	25.9	25.8	25.8	24.9	22.6	19.6	16.9	15.7	15.1	14.2
8	13.3	12.9	13.3	13.6	12.7	12.9	15.1	19.2	22.5	24.4	25.4	26.6	27.3	27.7	28.3	28.4	27.9	27.0	23.7	20.7	19.6	17.4	16.4	16.0
9	15.5	15.7	15.5	15.2	14.2	14.5	17.0	19.3	21.5	23.5	25.6	26.8	27.5	26.6	28.1	28.1	28.0	26.0	24.2	22.4	21.1	19.6	19.0	18.7
10	19.5	20.2	18.6	17.8	18.4	18.2	18.2	19.0	18.5	17.3	18.4	19.7	20.6	21.8	23.1	24.1	22.6	22.8	21.6	20.2	19.5	18.4	18.3	18.5
11	18.2	17.6	16.1	15.1	14.5	14.1	15.2	16.8	17.6	19.4	21.7	23.4	24.9	26.0	27.2	27.4	27.0	26.3	23.8	20.9	19.1	17.5	17.3	16.7
12	16.0	15.6	15.2	14.7	14.2	14.2	16.1	18.6	20.9	23.4	25.3	26.8	27.9	28.7	29.2	29.3	28.9	27.6	24.8	22.6	20.1	19.2	18.4	19.3
13	19.2	17.6	15.4	14.6	14.1	12.5	15.0	17.1	18.9	21.0	22.7	24.0	25.3	26.4	27.2	27.9	27.9	27.1	24.6	20.3	17.8	17.3	17.3	16.6
14	17.1	17.2	16.4	15.4	14.7	14.9	17.3	20.8	22.5	24.9	26.0	27.4	27.9	28.6	28.7	29.1	28.3	27.0	24.0	21.0	17.6	17.1	18.0	17.0
15	16.4	14.7	13.4	12.8	12.2	12.0	15.6	19.3	22.2	25.2	27.4	29.5	30.9	31.5	31.5	31.5	31.0	29.3	25.6	21.2	20.1	17.3	16.6	15.1
16	14.7	14.6	14.5	14.0	13.9	13.0	16.4	20.3	23.9	27.7	29.8	30.9	31.8	32.8	32.9	33.1	32.4	30.7	27.8	23.4	20.4	19.5	17.8	16.9
17	17.1	16.3	15.5	15.3	15.8	15.8	17.7	21.3	24.9	28.8	30.4	32.1	34.3	35.2	35.5	34.9	33.9	32.3	27.8	25.7	20.0	18.8	17.9	16.9
18	15.4	16.4	15.2	13.8	12.6	12.4	16.1	19.9	22.2	24.4	26.3	28.3	30.0	31.2	31.8	32.1	31.1	29.4	26.0	21.5	19.4	18.8	17.6	15.4
19	15.4	14.0	13.7	13.2	12.3	11.9	14.8	20.0	22.0	25.2	27.6	29.8	32.0	22.5	34.1	34.1	33.2	30.9	26.1	21.2	19.5	18.3	17.4	16.7
20	15.4	15.9	15.0	15.0	15.0	14.4	17.7	20.6	24.4	27.6	30.3	32.0	33.2	34.1	34.6	34.3	33.7	32.3	27.6	23.1	20.6	20.0	18.4	17.2
21	16.5	15.8	16.2	16.6	16.8	16.6	18.6	22.2	25.6	28.9	31.3	32.8	34.0	34.9	35.6	36.4	36.9	36.2	33.0	27.2	24.8	24.5	22.3	19.9
22	19.5	19.2	18.6	19.6	19.3	20.3	22.3	25.4	27.0	29.2	31.1	32.4	34.0	36.0	36.7	36.6	35.9	34.3	29.1	26.3	25.0	22.9	22.4	22.4
23	22.7	22.3	23.4	25.0			25.4	26.5	28.1	30.9	33.3	34.2	35.0	35.3	35.1	34.1	33.7	33.6	29.3	27.6	26.8	25.6	23.2	22.1
24	21.4	21.7	19.9	18.0	19.1	19.0	19.8	23.4	26.3	29.2	32.6	35.0	36.4	37.3	37.8	36.7	35.2	31.9	29.7	26.1	23.4	22.4	21.5	19.3
25	18.0	18.9	17.6	16.3	16.2	16.5	18.2	22.1	26.1	29.6	32.5	35.3	36.8	38.3	38.2	37.4	36.4	33.5	29.5	25.0	22.4	19.6	18.1	18.6
26	17.7	18.3	19.8	19.3	17.0	18.1	19.2	21.0	24.3	26.7	30.6	33.2	35.9	35.4	34.3	32.8	32.1	30.1	30.9	28.7	28.0	29.5	29.0	27.6
27	27.4	26.7	24.6	24.2	23.1	23.4	24.6	24.6	25.7	26.5	26.7	27.5	29.2	32.4	33.5	34.9	35.1	31.6	27.0	24.8	24.1	23.8	24.5	23.1
28	22.9	20.9	20.6	20.6	19.5	18.6	19.9	23.0	25.9	29.4	31.7	33.3	34.3	35.5	36.4	36.4	35.2	33.1	28.8	25.4	24.1	23.3	21.5	22.3
29	22.0	21.1	19.0	18.8	18.1	17.5	19.8	23.1	25.0	27.3	29.3	30.7	31.4	32.1	32.6	32.7	32.1	31.1	28.2	25.9	24.0	23.7	23.5	21.8
30	19.9	17.8	16.6	15.0	15.2	16.6	17.8	19.1	21.8	23.2	23.8	24.3	25.0	25.6	26.1	26.1	25.5	24.5	21.8	19.8	19.7	18.4	17.8	18.0
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	15.1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	24.5	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

September hourly temperatures for Lassen Canyon Nursery in Redding, CA 1999

September, 1999 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	13.3	12.1	12.5	12.0	12.0	11.6	13.1	16.6	19.1	21.6	23.0	24.0	24.5	26.2	26.9	26.7	26.5	24.2	20.0	17.7	16.0	15.0	12.8	12.2
2	11.9	11.3	11.1	11.0	9.1	8.9	11.1	16.3	18.4	21.4	23.9	25.4	26.9	27.6	27.8	27.4	26.4	25.0	20.9	18.6	17.7	16.2	14.4	13.9
3	15.1	15.0	14.0	12.2	11.8	10.7	12.2	16.8	20.6	23.3	25.8	27.9	29.3	30.0	29.7	30.5	29.8	28.7	23.8	21.8	19.0	18.8	20.6	18.9
4	18.9	18.8	17.4	17.3	17.0	16.7	17.4	19.2	22.5	26.4	29.3	31.5	32.9	33.9	34.6	35.8	34.7	29.6	26.2	21.3	19.5	17.8	18.0	15.8
5	14.5	14.1	13.5	12.5	13.0	12.8	14.2	18.2	22.2	26.1	28.1	30.2	31.4	32.0	32.3	32.2	30.8	28.8	23.9	21.0	19.7	17.9	16.7	15.6
6	14.9	14.6	15.8	15.4	14.7	14.0	16.1	19.6	22.9	26.1	29.3	32.3	34.2	34.9	34.7	35.1	33.3	30.4	26.2	23.2	20.2	18.8	18.0	17.4
7	17.8	18.4	16.5	16.1	16.7	17.5	16.9	20.6	24.8	27.6	30.2	31.4	33.2	34.4	33.9	32.4	31.5	29.4	24.2	21.1	20.1	18.3	17.0	16.4
8	15.4	15.2	15.2	14.6	13.3	12.6	13.8	18.5	22.7	26.5	29.4	31.9	34.3	35.7	36.1	35.4	33.6	30.7	25.9	22.1	20.9	19.8	19.0	18.2
9	18.8	19.0	18.7	19.4	20.1	19.3	18.5	22.1	24.9	27.4	27.8	28.3	31.2	33.2	34.3	34.1	32.5	31.5	28.6	24.4	22.7	22.3	18.7	19.1
10	19.2	18.1	17.4	15.7	15.0	15.0	15.3	18.1	19.8	21.5	23.8	26.6	28.0	29.2	29.9	29.6	29.9	26.8	22.9	20.6	19.2	18.6	18.0	17.2
11	18.0	18.0	18.0	17.9	17.8	17.4	17.7	20.7	24.7	28.4	31.7	34.1	35.8	36.9	37.9	34.2	29.9	26.4	22.9	21.8	20.2	18.6	18.1	18.0
12	17.5	17.7	17.3	16.8	15.4	13.8	15.4	18.9	22.3	24.5	26.4	28.2	30.3	32.0	32.6	32.0	31.5	28.8	24.3	22.1	20.8	19.8	18.9	18.6
13	18.2	16.9	17.3	16.3	15.0	14.4	15.2	18.4	20.2	22.6	25.8	28.5	29.5	31.3	31.8	32.1	31.4	28.2	24.4	22.7	21.0	19.0	18.7	19.0
14	16.7	15.5	14.9	15.1	14.2	12.8	14.1	19.1	23.4	26.6	28.7	30.9	33.6	37.0	37.1	36.6	34.8	31.5	26.3	24.1	21.7	20.3	19.6	17.8
15	16.1	15.7	14.7	14.0	13.2	12.4	13.7	17.8	20.1	23.4	25.7	27.8	29.4	30.1	31.3	31.2	29.8	26.8	23.0	21.6	19.6	18.3	16.9	16.6
16	17.0	16.8	16.1	16.3	15.6	14.2	14.4	17.8	20.7	23.6	26.8	29.0	30.8	31.3	31.7	31.0	29.6	27.0	23.9	20.9	18.8	17.1	16.5	16.7
17	16.8	15.3	14.9	14.7	14.9	14.0	15.7	18.4	21.6	25.3	28.5	30.5	31.8	32.5	33.0	32.8	31.7	28.4	23.5	20.5	19.5	18.0	16.2	15.8
18	16.0	13.9	14.2	14.2	15.6	15.8	16.1	18.8	21.3	23.6	25.7	27.7	29.4	27.9	28.1	27.5	27.4	24.9	23.1	21.8	20.2	19.3	19.4	18.3
19	17.7	18.2	16.7	17.5	16.8	16.2	17.0	17.7	19.1	22.2	24.8	26.9	28.2	29.1	29.8	29.6	28.5	26.4	23.3	21.7	20.9	19.5	17.8	16.7
20	16.4	15.3	14.3	13.6	13.0	12.4	13.5	16.2	19.1	21.0	23.2	25.1	27.1	28.6	29.0	28.5	27.3	25.0	21.9	20.7	19.2	18.0	18.5	18.6
21	16.8	15.4	15.5	15.0	15.4	15.7	16.9	19.8	23.3	26.3	25.8	31.3	32.0	33.0	33.1	32.6	31.3	29.5	24.0	20.4	18.4	16.8	16.6	15.6
22	16.6	17.3	17.7	17.8	18.4	17.7	16.8	19.8	21.7	23.7	26.3	29.5	30.7	33.3	34.5	33.2	30.8	29.6	27.7	26.1	24.3	23.0	21.5	19.3
23	18.5	18.9	17.9	17.1	16.3	15.8	16.9	20.8	23.7	26.6	29.7	31.2	31.8	32.4	32.5	32.0	30.0	26.8	24.0	22.5	21.5	20.4	19.6	18.8
24	17.5	16.9	16.4	15.4	15.6	14.3	15.7	19.7	23.1	25.3	27.5	29.8	31.0	31.6	32.4	32.5	31.0	27.6	24.2	21.7	20.1	19.1	17.9	17.8
25	18.8	19.3	18.6	18.2	19.1	18.4	18.4	21.0	24.1	27.2	30.2	31.6	32.7	33.6	34.0	33.9	33.6	32.0	28.6	27.8	27.6	27.1	26.0	25.0
26	24.3	23.6	22.8	21.9	21.5	21.4	21.7	22.8	24.3	25.6	27.6	28.8	29.9	31.0	31.3	32.1	32.0	30.1	28.1	26.8	25.9	24.5	23.8	23.6
27	23.2	22.1	21.8	21.0	20.4	19.9	19.5	20.4	21.7	23.1	24.8	26.5	27.9	28.8	29.6	30.0	29.5	28.0	26.8	25.6	24.2	22.7	20.7	19.8
28	20.5	20.6	20.1	19.9	19.6	18.8	17.4	19.1	20.7	23.6	26.0	27.5	28.8	29.9	30.7	31.0	30.6	27.5	24.5	22.3	22.2	19.8	19.6	19.1
29	18.5	18.4	18.2	18.0	17.5	16.4	16.1	18.6	21.5	24.6	27.4	29.9	31.7	33.5	33.6	33.1	31.8	28.3	22.6	20.0	18.5	18.0	18.3	19.1
30	18.0	16.8	16.2	16.2	16.1	14.6	13.7	15.7	18.8	22.6	25.9	29.0	31.0	32.2	32.5	31.1	32.0	27.7	22.0	18.8	18.4	17.3	16.7	15.4

October hourly temperatures for Lassen Canyon Nursery in Redding, CA 1999

October, 1999 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	16.92	17.13	16.83	15.97	16.12	16	15.71	16.71	19.52	23.01	25.84	28.19	30.42	32.22	32.91	32.27	30.01	26.44	21.44	18.58	17.5	16.45	15.66	15.32
2	13.85	13.14	12.73	12.14	11.71	11.36	10.54	13.59	17.7	20.47	24.26	26.01	27.79	28.92	29.27	29.47	27.73	24.16	20.64	18.39	17.08	15.88	15.27	14.71
3	14.01	13.52	12.79	12.38	11.99	10.47	10.63	13.96	16.26	18.2	20.41	22.75	24.53	26.07	26.9	26.7	25.18	22.68	19.59	17.8	16.68	15.17	14.17	13.15
4	12.6	12.9	11.82	10.67	9.69	9.48	9.46	12.82	15.47	17.83	20.42	22.16	23.34	24.27	24.39	23.66	22.96	21.78	20	18.75	18.48	17.91	16.77	15.3
5	13.82	12.46	10.2	9.74	9.01	8.16	8.47	12.34	15.73	17.11	18.11	19.34	19.41	19.98	20.01	19.69	19.21	18.4	17.11	17.25	16.39	14.9	16.15	16.98
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August 2000 Outlook Hourly Temperature Summary (°C).

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	18.9	18.2	17.7	17.1	16.6	16.1	15.9	16.9	18.4	20.2	22.7	23.9	27.0	29.0	30.4	32.4	31.7	28.6	26.9	25.1	23.3	21.1	19.4	18.5
2	17.8	17.1	16.6	15.9	16.0	15.6	16.2	18.0	18.1	18.6	19.5	21.9	25.6	27.0	28.1	25.1	27.0	25.5	23.3	22.0	21.0	19.4	18.4	18.0
3	18.8	18.4	17.0	17.5	17.6	17.7	16.8	18.1	17.5	19.3	18.3	20.0	21.6	20.5	20.4	20.0	20.0	19.8	19.9	19.6	18.9	18.7	18.3	17.4
4	16.8	16.2	15.8	15.6	15.2	15.0	14.8	15.1	16.3	18.9	19.9	21.7	23.6	23.3	27.1	28.7	28.5	28.0	24.5	23.9	22.2	20.7	19.5	19.2
5	19.1	18.3	18.1	17.3	17.6	17.2	17.6	18.0	18.6	19.1	20.6	20.3	23.0	24.0	25.3	27.0	25.3	25.0	24.0	22.6	21.6	20.1	19.5	18.7
6	18.1	18.1	17.5	17.1	17.0	16.9	16.4	16.7	18.2	19.7	20.5	22.3	24.5	27.1	25.2	25.4	23.3	22.7	19.6	19.7	18.4	18.2	17.5	17.4
7	16.7	16.2	15.9	15.5	15.2	14.8	14.4	15.1	16.6	18.2	19.4	21.8	23.1	26.1	27.8	29.3	29.5	26.0	23.8	22.8	21.0	19.9	19.3	19.1
8	17.5	17.4	17.1	17.1	17.0	17.0	16.9	17.2	17.5	18.4	17.4	19.4	19.5	20.9	20.9	21.2	20.3	20.2	19.8	19.5	18.5	17.5	16.8	16.1
9	15.6	15.0	14.7	14.3	13.8	13.4	13.1	13.9	15.1	16.7	18.4	19.8	22.4	21.1	24.2	25.6	27.2	23.2	22.1	20.5	18.9	17.8	16.8	16.2
10	15.7	15.0	14.5	14.3	14.5	14.5	14.3	14.5	16.7	18.1	18.7	21.8	23.3	24.5	27.0	27.7	27.9	24.9	23.7	22.1	20.7	19.2	18.3	17.6
11	17.8	17.2	16.3	15.8	15.2	14.7	14.4	15.5	17.0	19.2	20.9	23.1	24.6	26.5	28.0	28.9	27.5	28.1	25.2	23.8	22.3	21.1	20.4	19.9
12	19.3	19.2	19.0	19.0	18.7	18.7	19.1	18.7	19.8	20.0	20.5	19.9	20.5	20.6	21.2	28.4	27.0	23.8	22.7	21.0	19.6	18.8	17.5	16.8
13	16.4	15.7	15.5	14.9	15.0	14.1	13.7	14.2	15.5	16.6	17.7	19.2	20.9	23.1	26.3	24.2	26.3	22.4	21.5	19.9	18.6	16.6	16.0	15.5
14	14.9	14.4	13.8	13.3	13.5	13.1	12.6	13.9	16.1	17.3	19.2	20.9	20.8	22.8	20.5	21.8	23.7	22.1	21.1	19.7	18.2	17.2	16.1	15.7
15	14.7	14.1	13.8	13.4	13.8	14.0	13.9	14.1	14.5	15.4	17.2	17.4	20.0	19.5	22.3	23.0	21.5	20.7	19.7	17.9	16.7	14.7	13.8	13.1
16	12.7	12.2	11.8	11.5	11.2	10.4	10.4	11.6	13.5	16.0	19.0	20.2	22.2	24.6	25.4	25.8	26.5	24.5	23.2	21.1	18.6	16.7	16.5	16.8
17	17.2	14.9	14.8	14.6	14.8	14.3	13.5	13.9	15.1	16.5	18.0	19.0	20.4	21.2	22.1	21.4	22.2	21.5	20.6	19.0	17.8	16.4	15.6	14.7
18	14.2	13.8	13.3	12.8	12.6	11.9	12.0	12.3	13.3	13.8	15.5	16.3	18.4	19.7	22.2	25.1	23.5	20.1	19.9	18.5	17.0	15.5	15.0	14.1
19	13.7	13.2	13.0	12.8	12.5	12.2	12.0	12.5	14.0	15.7	17.3	19.0	21.0	22.8	23.9	25.3	24.3	22.9	21.4	19.5	18.5	17.6	16.8	16.3
20	15.7	15.3	15.0	14.6	14.4	14.1	13.7	13.8	14.2	15.7	16.2	18.7	22.3	24.1	26.0	26.7	25.5	23.7	22.5	19.8	18.4	17.9	16.6	15.7
21	15.5	15.2	15.4	15.4	15.4	16.0	16.0	15.0	15.2	15.5	17.0	18.7	20.2	22.6	22.2	19.9	20.6	16.9	16.8	15.7	15.1	14.1	13.3	12.9
22	12.9	12.6	12.2	11.3	11.1	10.7	10.6	11.5	13.4	16.2	18.4	19.4	22.3	24.2	25.6	22.3	25.9	21.5	21.1	19.3	16.9	14.8	13.9	13.3
23	12.7	12.3	11.7	11.1	11.0	10.7	10.0	11.0	13.0	15.6	18.5	20.5	22.1	25.2	26.5	28.4	26.2	25.1	23.8	22.2	20.2	18.1	17.3	16.8
24	15.3	14.8	14.7	14.3	14.2	14.3	14.1	14.3	15.9	18.6	21.3	23.0	24.6	27.6	29.5	30.3	28.9	27.4	25.8	23.1	19.8	18.3	20.0	17.5
25	16.7	15.9	15.6	14.9	14.5	14.1	13.7	14.7	16.4	18.6	19.9	21.9	23.1	24.0	24.9	25.1	26.5	25.1	25.0	21.5	19.3	18.1	17.4	17.9
26	17.6	17.2	16.2	16.2	15.0	15.8	15.8	15.7	17.1	18.6	20.2	20.8	20.6	22.1	26.3	29.7	26.5	25.2	24.7	23.0	19.6	18.4	17.8	17.4
27	17.4	17.1	16.5	16.2	15.7	15.8	15.6	15.4	17.1	19.2	21.5	23.9	26.1	27.6	29.6	30.3	28.4	27.7	25.6	23.7	21.4	19.2	17.7	16.5
28	15.8	14.6	14.2	13.3	13.0	12.2	11.8	12.3	13.8	14.4	14.7	16.8	18.9	21.1	19.7	19.5	19.5	19.1	17.3	15.7	15.5	14.6	14.1	13.6
29	12.8	12.3	11.5	10.8	10.2	9.7	9.0	9.0	10.4	12.1	13.8	14.6	15.8	17.4	18.1	18.3	18.3	16.9	16.3	14.9	13.5	11.8	11.1	10.4
30	9.9	10.9	10.3	9.7	9.8	9.0	9.3	9.7	10.4	11.4	11.9	13.1	13.5	14.6	14.6	13.7	13.8	13.3	12.5	10.7	10.2	9.9	9.8	10.0
31	10.0	9.6	9.4	9.3	9.1	9.1	8.9	8.8	8.8	9.0	9.6	11.0	11.5	11.6	12.3	12.4	12.1	11.9	11.7	11.4	10.5	10.1	10.1	9.8

September 2000 Outlook Hourly Temperature Summary (°C).

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	8.9	7.8	6.9	6.6	6.0	6.0	5.8	6.1	7.2	9.1	10.1	11.3	11.5	12.1	13.6	13.5	14.7	14.2	13.9	13.1	12.4	12.3	12.5	12.5
2	12.3	12.1	11.7	11.5	11.0	10.5	10.6	10.3	10.7	12.0	13.5	15.4	16.8	17.6	18.7	17.9	19.2	15.8	15.1	13.8	12.6	11.4	11.0	11.0
3	11.0	10.9	10.6	10.5	10.3	10.3	10.2	9.8	9.6	9.5	9.5	9.6	9.5	9.3	9.2	9.2	9.2	9.2	9.3	9.1	8.8	8.8	8.7	8.8
4	8.9	9.1	9.1	9.3	9.5	9.6	9.8	10.0	10.2	10.8	13.1	14.4	16.4	17.2	17.9	18.4	17.0	16.9	15.3	13.5	12.2	11.5	11.2	10.8
5	10.2	10.2	10.0	9.9	10.1	10.3	10.4	10.7	11.3	12.0	12.6	13.6	13.9	14.0	14.1	16.3	15.3	14.9	14.7	14.3	14.0	13.7	13.3	12.7
6	12.9	12.6	12.7	12.8	12.4	12.3	12.4	12.7	13.4	13.8	14.1	15.1	15.7	17.7	18.8	19.0	19.2	18.5	17.4	15.9	14.8	14.6	14.3	13.9
7	13.5	13.4	13.5	13.1	13.2	13.3	12.9	12.6	12.8	14.1	13.9	15.5	15.5	15.4		16.7	15.7	15.1	14.1	13.1	11.9	11.2	10.7	9.8
8	9.6	9.0	8.7	8.7	8.8	9.1	8.3	8.6	9.9	11.7	14.7	16.2	17.7	19.3	20.2	20.5	19.8	18.8	17.6	16.0	13.6	12.9	13.0	
9	11.1	11.1	11.1	11.0	10.7	11.3	10.7	10.7	11.3	13.4	14.4	16.2	18.6	20.1	20.9	20.1	18.4	18.5	16.8	14.8	14.9	14.5	14.3	14.2
10	13.9	13.3	13.0	12.4	11.7	11.2	10.8	11.4	11.5	12.0	12.3	13.4	14.9	15.9	17.5	16.4	16.1	15.3	13.8	12.3	10.6	10.2	10.5	10.8
11	10.6	10.2	9.1	9.9	9.3	8.3	7.6	7.4	8.6	10.7	13.4	12.8	14.8	15.5	13.6	12.2	14.4	13.2	12.3	11.4	10.2	9.1	8.8	8.5
12	8.1	7.5	7.1	6.8	6.3	6.0	5.6	5.6	6.7	8.3	11.2	12.7	14.0	15.5	15.6	15.8	15.4	13.1	12.7	11.2	10.3	9.7	10.1	9.5
13	10.0	10.0	9.9	9.7	9.2	8.3	7.7	8.0	9.1	11.1	13.6	14.7	16.4	17.8	17.3	17.0	17.4	16.8	15.5	13.7	11.5	12.4	10.7	10.0
14	9.8	8.9	9.1	9.8	10.1	10.2	9.8	10.2	10.6	11.6	12.8	15.0	16.0	18.3	17.0	16.1	16.5	16.0	15.0	13.5	10.7	10.8	9.6	9.0
15	8.4	7.8	7.4	7.2	6.6	6.2	5.9	5.9	7.7	10.2	13.2	13.9	15.0	16.9	16.9	18.6	19.5	18.9	17.7	15.7	14.3	14.3	14.3	14.0
16	13.3	13.1	12.7	12.6	12.4	12.2	12.2	12.0	12.8	12.5	14.1	16.2	17.8	20.3	21.2	21.5	20.9	20.9	19.5	16.8	15.3	14.9	14.8	13.4
17	12.9	12.7	11.9	11.4	11.1	10.5	10.2	10.1	11.0	12.6	14.7	16.3	17.9	18.6	20.0	19.8	19.4	18.9	17.8	15.1	14.0	14.0	13.9	13.5
18	13.3	12.9	12.5	12.5	12.1	11.9	11.1	11.0	12.1	13.5	15.4	17.1	18.6	19.8	19.7	19.5	20.2	19.8	18.4	18.0	16.3	16.1	15.5	15.2
19	15.4	14.9	14.6	14.5	14.4	14.4	14.7	14.6	14.5	14.1	14.4	14.9	15.3	16.9	17.4	18.4	16.5	16.4	14.9	14.2	13.6	12.4	12.5	12.4
20	11.9	11.8	11.6	11.5	11.6	11.4	10.7	10.7	10.7	11.7	11.9	12.2	12.8	11.3	12.4	12.5	12.3	12.0	11.7	11.0	10.8	10.2	10.1	9.9
21	9.1	9.1	8.6	8.5	8.8	8.0	7.6	7.8	8.2	8.2	8.7	9.8	11.5	11.6		13.0	13.0	11.3	9.8	8.9	7.5	8.2	8.2	8.1
22	7.8	7.2	7.0	6.5	6.0	5.6	4.7	3.6	3.5	3.3	3.9	4.6	5.4	4.8	4.8	5.4	5.0	4.6	4.5	4.2	4.1	3.9	3.9	3.8
23	3.6	3.2	3.2	3.1	2.9	2.5	2.5	2.7	2.8	3.1	4.0	5.8	4.7	4.7	5.2	5.4	5.4	5.0	4.8	4.5	4.1	4.1	4.2	4.0
24	3.8	3.7	3.5	3.0	3.0	2.3	1.9	1.4	1.6	3.0	5.3	6.6	7.8	9.0	10.1	10.3	9.7	9.1	7.4	6.5	5.8	5.3	5.6	5.6
25	5.5	5.3	4.7	4.2	3.8	3.4	3.0	2.6	3.3	5.1	7.2	9.4	11.0	12.3	13.4	13.8	13.1	12.4	10.4	9.2	9.0	9.0	8.2	8.2
26	7.5	7.4	7.1	7.0	6.5	6.3	6.1	5.3	6.0	7.7	9.3	11.2	13.6	14.4	15.4	15.7	15.2	14.5	12.8	11.2	12.3	10.8	10.0	8.9
27	7.7	7.7	7.9	7.7	7.7	7.6	7.4	7.1	7.1	7.5	7.9	8.1	9.1	10.0	12.1	12.8	11.1	10.1	10.3	9.4	8.7	8.1	7.1	6.4
28	5.6	4.9	4.5	4.2	4.3	4.1	4.0	3.6	4.0	5.9	8.3	10.6	13.1	14.6	15.4	15.8	15.3	14.3	12.4	10.3	9.8	9.8	9.5	9.3
29	8.7	8.5	8.3	8.2	7.2	6.9	6.1	6.7	7.1	8.9	10.7	12.9	13.7	14.4	15.4	15.9	15.4	14.4	12.9	11.2	11.0	10.8	10.4	9.9
30	9.1	8.9	8.2	8.0	7.7	6.8	6.8	6.2	6.8	8.7	11.3	13.6	15.5	16.7	17.2	16.4	15.9	15.0	14.0	12.6	13.1	11.8	11.6	11.2

August 2000 Meadow Lake Temperature Summary (°C).

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	13	12.7	12.1	11.7	10.8	10.9	11	16.1	17.3	18.1	18.6	19.6	20	19.7	18.3	17.8	19.6	20.2	19.8	20	19.9	18.6	16.7	13.9
2	14.3	15.1	15.3	15.3	15.1	15.1	14.1	15.2	16.3	16.7	16.7	17.8	19.1	19.9	22	22.7	22.1	22	22.9	21.4	20.1	17.5	16.1	13.8
3	12.2	11.3	10.2	9.4	9.4	8.6	10.2	12.2	13.8	16	16.2	17.2	18.6	18.5	21.5	21.4	22.1	23.1	22.1	21.4	20	18.1	16.8	14.6
4	12.8	13	11.9	11.7	10.9	9.4	9.5	12.7	16.2	17.5	19.5	21.6	22.3	24.2	25.2	26	24.3	23.5	18.5	20.3	18.5	16.9	14.7	13.8
5	12.5	11.7	10.9	10.6	10.7	10.4	9.1	12.4	16.6	20.2	21.4	23.7	24.7	20.7	19	24.5	21.8	21	20.2	21.2	20.4	16	14	12.3
6	10.9	10.2	9.5	9.6	9.7	10.2	9.6	11.6	13.8	18.1	21.6	21.4	24.5	26.5	23.2	24.8	19	19.4	20.5	18.5	18.1	16.6	15.5	15.1
7	15.5	15.3	15.8	16	15.2	15.4	15.3	15.1	15.3	15.3	16	15.8	16.5	15.1	15.5	15.1	15.7	15.2	15.4	15	14.6	14.6	14.3	14.6
8	13.8	12.8	11.7	11.3	11.1	10.2	9.9	11.6	13.7	15.6	17.5	19.1	20.5	19.9	21.4	22.5	22.2	22.9	22.5	22.2	19.6	14.2	11.7	11.1
9	10	9.6	8.8	8	7.8	7.2	6.2	8.2	12.6	14	15.9	17.5	19.5	20.1	20.4	21.1	21.9	21.6	21.4	20.6	18.8	16.1	15.1	14.7
10	15.6	14.4	13.8	13.6	13.7	13.9	13.8	14.2	14.9	17.2	18.6	19.3	20.2	21.5	21.8	22.7	22.2	21.6	20	19.8	17.8	16.5	15.4	14.5
11	13.5	13.7	14.2	14.6	14.5	14.2	14.4	14.5	14.4	14.5	14.4	14.4	14.5	13.7	13.6	13.6	13.3	12.7	12.1	11.8	11.3	11.1	10.9	9.8
12	8.9	8.3	8.6	7.3	7.3	7.4	8.1	9	9.7	11.5	12.8	13.5	12.6	14.3	15.5	17.1	17.7	18.9	18.7	17.8	15.8	11.9	9.8	7
13	6.6	4.4	3.3	2.7	2.4	2.1	2.6	4.8	7.6	11.1	13	15.1	17.1	17.4	16.2	17.2	18.1	18.7	18.6	17.4	14.4	13.6	13.7	13.1
14	11.9	11.6	11.7	11.7	10.8	10.3	10	10.5	10.9	11.4	11.8	12.8	13.5	15.5	17.6	17.4	16.4	16.1	18.2	17.3	15.9	10.7	8.2	6.2
15	5	4.7	3.8	3	2.2	2.1	1.3	3	10.1	13.3	16.3	19.1	21.8	22.6	23.7	23.3	23.6	23.6	23.2	20.5	17.3	15.5	15.2	16.5
16	16.6	15	13.7	12.9	12.8	12.8	12.7	12.7	12.9	13.6	15	15.1	15.9	15.5	17	15	15.3	14.7	15.7	14.4	11	8.7	7.5	6.5
17	5.7	4.2	3.8	4.3	3.2	2.3	1.5	2.6	9.6	12.8	14.2	16.5	17.1	17.7	18.4	19.3	19.4	20.3	19.6	19.1	17	13.9	10.8	12.7
18	12.5	10.5	7.9	8.2	7.5	7.5	8.9	10.1	13.2	15.3	18.9	20.4	21.4	23.3	24	24.9	24.3	24.2	23.9	23	20.8	19	18.9	18.8
19	18.8	18.4	16.9	16.7	15.7	15.6	14.1	14.5	15.2	16.7	17.7	18	18.2	19.9	20	21.8	22.2	21.9	22.8	21.8	18.3	13.4	11.1	9.4
20	9	9.8	10.4	10.5	11.1	10.6	10.9	10.5	11.1	12.9	12.9	13.9	15.1	18	18	18.4	19.8	17.9	14.2	14.4	11.1	10.7	7.8	7.4
21	6.5	6.1	5.5	6.4	6.1	5.5	5.5	5.4	9	11.7	14.4	17.5	18.8	19.6	20	20.5	21.3	21.6	21	20	16.7	12.3	9.8	8
22	7.4	5.2	5.3	4.7	5.1	3.9	3.5	6.1	9.9	13.9	16.9	20.4	22.1	23.7	23.9	24.3	24.5	25.1	24.6	23.6	18.2	14.4	12.8	11.3
23	11.5	9.5	8.6	7	6.5	5.8	5.4	5.6	12.5	16	20.1	23	25.4	26.5	27.6	28.5	28.1	28.2	27.3	25.8	20.3	16.5	14.5	13.2
24	12.8	11.2	10.4	10.3	9.2	8.9	7.8	12.8	14.5	16	18.7	18.4	18	22.3	22.8	23.9	24.7	19.8	19.6	20.4	16.4	13.9	12.9	10.7
25	10.9	9.7	9.1	8.1	7.9	7.2	7.3	9.8	13.7	14.4	17.5	19.8	20.7	22.2	23	22.7	22.5	21.7	21.8	21	19.2	17	15.2	14.9
26	13.7	11.5	10.5	10	9.3	8.8	7.9	8.2	12.4	16.1	18	19.6	21.5	23.7	25.4	26.4	25.9	19.6	16.1	14.8	13.7	12.3	11.3	10.6
27	10	8.4	7.7	8	5.5	5.7	4.2	4	8.5	12	13.9	15.4	14.9	15	14.6	15	15.1	13.1	13.1	12.5	12	9.9	9.5	9.5
28	9.3	7.6	7	6.2	6.4	6.3	5.8	6.7	7.8	7.6	8.2	9.2	10.4	9.5	11.8	12.7	11.8	11.2	11.5	10.8	9	4.6	3.1	1.7
29	0.2	0.1	-0.4	-0.2	0.9	-0.7	0.7	0.8	4.5	7.2	8.2	9.9	11.2	12.4	12.9	12.9	13.3	13	12.7	11.5	9.9	5.5	4.2	3.5
30	1.8	0.9	0.6	0.1	0.4	0.5	0.6	1.5	3.5	5.8	9.4	11.8	13.1	11.7	12.9	9.7	10.5	12	12	10.7	9.3	8	8	6.8
31	6.9	5.9	2.1	0.6	-1.1	-2.1	-2.3	-1.9	3.1	6.8	9.1	11.3	13.6	13.1	13.8	14.1	13.9	13.8	13.2	12.4	11.8	11.3	11.3	11

September 2000 Meadow Lake Hourly Temperature Summary (°C).

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	9.5	9	8.5	8.6	9.1	9	8.7	8.9	9	9.4	10.4	11.4	12.4	13	11.7	11.7	12.5	12.3	11.9	11.5	11	11.2	11.3	11.3
2	10.9	10.6	10.3	9.3	8	7.7	7.5	7.9	8.8	10.8	11.1	12.2	13.3	13.1	13.6	14.4	14.4	14.2	13.7	12.7	11.6	10.6	10.7	9.6
3	9.5	10.2	10.4	8.9	8.3	8	8	8	8.1	7.9	8.1	7.9	8	8.3	8.9	9.4	9.7	9.8	9.9	10.1	10.1	10	10.2	10.3
4	9.9	9.5	9.5	9	9.2	9.4	9.5	9.5	9.4	10.1	10.4	10.8	11.7	13.5	13.8	13.4	15.4	15.2	14.2	12.5	10.7	8.7	8.4	8.4
5	8.2	6.1	4.6	6.5	7.1	7.2	5.8	6.2	7.4	10.4	11.3	12.8	14.3	18	19	18.8	19.1	18.5	18.5	16.4	15	14.8	14.4	13.8
6	13	13.6	13.2	12.8	12.2	11.8	11.6	10.9	10.8	11.3	11.7	11.7	11.9	11.9	12.3	12.2	11.9	11.6	12.9	11.3	7.7	5.6	3.4	2.2
7	0.4	0.3	0.7	0.8	1.3	2.6	2	1	3.3	9.1	12.3	14.5	17.7	19.8	20.9	21.9	22.7	22.2	20.9	18	12.4	14.7	13.4	10.1
8	12.4	12.4	12.4	11.9	9.5	7.3	6.7	6.3	6.3	12.7	13.1	14.5	16.4	19.1	19.3	17.2	16	14.3	12.7	12.2	12			
9	11.3	11.1	10.5	10.4	10.5	10.3	9.6	8.7	8.3	8.7	8.9	9.3	9.2	9.7	10.4	10.5	12.8	12.6	12.1	10.5	8.5	6.2	5.9	5.9
10	4.9	5.3	4.3	3.8	4.2	3.8	4.7	3.5	5.6	7.9	9.6	10	12.1	12.4	11.7	13	11.5	9.7	10.9	8.8	7.9	6.4	5.7	5.2
11	5.6	3.2	1.5	1.1	1.6	1.2	2.1	2.8	3.8	5.4	7.2	10.4	12.1	13.3	14.3	15.1	16.4	15.8	14.3	11.7	7.5	5.6	6	9.6
12	8.6	8.6	9	9.4	9.3	9.2	9.7	9.3	9.8	11.2	12	13.2	15	16.3	17.6	18.1	18.3	18.2	17	14.5	11.7	9.4	6.4	5.7
13	6.4	5.3	5	5.7	5.1	4.6	4.6	4.6	5.9	8.7	11.1	13.8	16.1	16.7	17	17.9	18.5	17.8	15.9	12.7	8.4	6	3.6	2.8
14	1.6	0.7	-0.7	-1.2	-1.5	-1.3	-2.2	-2	0.3	7.3	9.6	13.1	17.4	19.9	21.3	21.8	22.7	22.3	20.7	16.8	17.4	17.3	16.4	16.3
15	15.8	11.6	10.2	9	6.9	6.3	5.2	5.2	7.8	13.8	18.2	20.8	22.7	24.3	24.6	24.9	24.8	24.6	22.8	20.6	15.1	12.5	8.9	7.9
16	6	4.9	3.7	1.9	1.3	-0.1	0.4	1.3	4.5	8.9	14.8	15.4	16.4	17	18.6	18.4	19.2	18.4	16.5	13.1	10.7	8.7	8.4	7.5
17	6.3	6.5	6.3	4.9	6	6.4	5.1	6	7.5	10.6	11.9	12.7	14.3	15	15.3	17.8	20	21	19.3	15.8	15.1	12.9	10.2	9.8
18	9.1	7.2	6.5	6.6	10.5	9.9	9.5	9.4	11.5	12.6	14.5	15	15.9	18.1	17.1	15.8	13.5	14.7	13.7	12.6	12.2	11.2	11	11.4
19	11.5	9.8	9.8	9.8	8.9	8.9	8.5	8.1	8.1	8.4	9.5	10.3	10.5	12.1	9.2	10.9	11	10.3	9.9	9.7	8.4	6.7	6.7	5.3
20	4.3	3.5	1.1	-0.5	-1.5	-1.3	-2.3	-2.8	-1.8	2.8	5.3	6.4	7.7	8.6	9.8	8.8	8.1	7.8	5	3.9	2.6	2.6	2.2	2.1
21	1.9	1.8	1.8	1.7	1.3	1.4	1.2	0.4	0.6	1.1	1.9	2.3	2.9	3.4	3.9	3.8	3.3	3.3	3.1	2.6	2.4	1.7	0.9	0.6
22	-0.2	-2.9	-2.8	-3.7	-4	-4.9	-3.3	-2.3	-1.1	0.2	1.9	3.6	3.4	3.5	4	4.4	4.7	4.1	3.4	3	0.2	-1.1	-1.4	-1.8
23	-2	-2.4	-2.6	-2.8	-2.4	-3	-3.6	-3.2	-1.6	0.6	2.7	3.8	7.3	9.3	10.9	12.8	15.1	15.1	12.8	11.3	5.8	4.7	3.4	1.8
24	-0.3	-0.9	-2.5	-2.7	-3.2	-3.7	-3.8	-3.8	-3	3.5	8.1	12.8	15.5	17.3	18.8	19.4	20.6	20.6	18.5	15.2	14.3	12.2	8.8	5.6
25	4.5	2.4	1.5	-0.1	-0.7	-1.4	-0.6	0.3	1.5	5.2	5.6	7.7	9.4	11.2	9.5	8.7	7.7	7	6.7	5.6	4.9	4.4	3.9	3.3
26	2.8	2.4	2.5	2.4	1.9	1.6	1.6	1.4	1.7	1.7	1.8	2	2.3	2.8	3.4	3.6	3.3	2.6	2.4	2.3	2.6	2.7	3.2	3.6
27	3.8	3.7	2	0	-0.7	-0.3	1.6	-1.1	-0.9	4	7.1	8.4	9.9	12.7	14.5	16	16.8	16.9	15.2	9.6	6.8	5	3.7	3
28	2.2	1.5	1	0.2	-0.1	-0.4	-1	-0.9	-0.2	3.7	8.5	12.2	14.6	18.4	19.8	21	20.4	20.8	18.2	12.3	9.2	6.9	5.6	4.4
29	3.6	2.6	1.5	0.7	0.4	0.5	-0.6	-1.2	-1.3	4.5	4.8	7	10.7	11.2	12.5	13.2	13.7	13.5	13	12.4	10.4	9.7	8.5	6.9
30	6	6.1	4.8	4.1	4.1	1.8	0.5	0	0.3	6.1	11.8	12.6	13.8											

August hourly temperatures for Gerber, CA 2000

August, 2000 Gerber, CA for Hourly of Chilling at Red Bluff, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1.0	25.5	24.9	23.7	24.6	24.6	23.9	25.1	26.6	28.8	30.0	31.9	33.1	34.0	35.3	36.2	36.9	36.6	35.3	30.2	27.3	26.1	25.2	24.5	24.4
2.0	25.5	25.5	24.2	21.2	20.6	20.6	23.8	27.9	29.5	32.1	33.7	34.6	35.5	36.1	36.5	36.4	35.7	34.5	32.5	29.7	27.5	27.6	25.2	24.3
3.0	22.9	21.1	20.6	20.1	19.3	19.7	22.5	24.4	26.2	28.4	29.7	30.4	32.1	32.6	33.2	32.9	33.5	31.7	30.4	28.5	24.8	23.5	24.4	23.7
4.0	22.9	21.6	19.7	20.4	20.6	20.6	19.5	23.3	26.2	27.8	28.9	29.6	31.0	31.7	32.2	32.9	32.8	32.1	29.6	25.6	23.8	22.3	21.9	21.3
5.0	20.2	19.9	19.5	18.4	18.7	17.9	21.1	24.6	27.5	30.1	32.5	34.4	35.7	36.0	36.1	35.8	35.2	33.2	30.1	26.3	24.9	24.2	23.5	22.5
6.0	20.9	19.6	19.4	19.4	18.4	17.8	21.5	24.7	28.3	31.2	33.0	33.9	35.1	35.5	35.7	35.4	34.9	33.3	29.8	25.7	25.0	24.1	24.3	21.8
7.0	20.7	19.3	18.5	18.4	16.9	17.0	19.7	20.5	21.8	24.9	26.3	27.9	29.2	30.6	31.0	31.0	30.2	28.3	26.5	24.1	23.5	21.6	19.1	18.1
8.0	18.3	16.0	15.0	15.2	14.4	13.6	16.6	18.9	21.8	25.0	27.3	29.5	31.1	31.9	31.9	31.9	31.1	29.8	27.0	22.0	21.8	21.1	19.1	18.5
9.0	18.0	17.7	17.7	16.9	15.3	14.8	18.0	20.2	22.7	25.6	27.4	29.9	31.5	32.5	33.0	32.9	32.1	30.2	27.4	23.0	21.9	21.9	21.0	20.0
10.0	19.5	18.1	15.0	14.3	14.2	13.8	16.0	18.1	20.6	22.8	24.6	26.4	28.1	29.4	30.0	30.2	29.6	28.7	26.3	21.8	19.3	18.1	17.8	17.0
11.0	16.2	15.9	15.5	16.1	16.0	16.2	18.0	21.4	24.4	27.1	29.6	31.6	33.6	35.2	36.1	36.2	35.4	33.3	28.7	23.5	21.2	20.2	19.2	18.5
12.0	17.5	17.2	17.5	17.4	15.8	16.9	20.0	23.3	26.4	29.6	31.8	33.4	34.6	35.2	35.7	35.8	35.0	33.2	29.2	25.0	22.7	22.5	22.2	20.2
13.0	18.4	17.9	17.3	15.9	15.7	15.2	18.5	22.1	25.5	28.0	29.7	31.7	33.3	34.4	34.9	35.3	34.9	32.8	28.2	24.0	23.4	22.1	21.0	21.2
14.0	21.4	19.8	18.7	18.2	17.6	17.4	20.0	23.5	25.7	28.4	31.1	32.5	33.9	35.0	35.4	35.2	34.5	32.6	28.0	23.9	24.3	22.1	21.3	21.4
15.0	19.2	20.6	20.3	19.7	19.0	18.6	20.0	23.1	25.8	28.0	30.5	32.9	34.0	34.5	35.0	35.2	34.5	32.5	28.5	24.5	22.4	21.8	19.1	18.5
16.0	19.2	19.2	20.2	19.0	17.8	17.8	20.3	24.0	26.6	28.9	31.5	34.1	36.0	36.9	37.5	36.8	36.1	33.8	29.2	25.6	23.9	23.1	22.7	22.3
17.0	22.6	22.7	21.4	20.5	19.8	19.4	21.1	24.0	26.5	28.6	31.1	32.8	33.7	34.4	34.9	34.6	33.6	31.9	28.1	24.9	25.7	22.3	21.8	21.5
18.0	19.5	19.0	18.5	17.0	15.3	13.9	17.0	20.8	22.9	25.5	27.4	28.6	30.3	31.6	31.9	32.0	31.4	29.7	25.2	22.0	21.3	20.2	19.4	18.3
19.0	18.2	16.6	15.6	14.9	14.6	14.1	17.3	19.1	21.7	24.2	26.1	27.7	29.0	29.7	29.7	29.5	29.2	28.0	25.1	22.7	20.7	19.8	20.0	18.3
20.0	16.6	15.8	15.2	14.7	13.8	13.5	16.0	20.3	22.6	24.5	26.8	28.8	30.0	31.2	31.7	31.8	30.9	28.9	24.9	22.4	20.7	19.7	18.4	17.7
21.0	16.7	15.1	15.0	15.7	15.3	14.2	17.0	21.8	23.7	26.1	27.5	29.4	30.9	32.1	32.1	31.6	30.4	28.5	24.8	22.2	21.6	20.0	18.2	17.2
22.0	17.1	16.5	16.3	15.4	14.9	14.6	17.9	20.7	24.4	27.5	29.5	30.9	32.1	32.6	33.0	32.9	32.1	30.2	27.9	22.7	21.1	20.5	18.9	17.9
23.0	17.0	16.8	16.3	14.8	14.1	14.4	17.1	20.2	22.4	24.9	26.9	29.0	30.1	31.1	31.5	31.2	30.6	29.1	26.9	24.3	22.6	19.3	19.4	17.2
24.0	16.8	15.7	14.4	14.1	13.4	12.2	15.2	18.8	22.3	25.2	27.4	30.0	31.4	32.3	32.9	33.1	32.8	32.1	28.3	22.6	20.2	19.1	18.1	17.8
25.0	17.0	16.4	16.5	16.3	16.2	16.4	18.3	21.2	24.5	27.7	31.0	32.8	34.0	34.4	34.7	34.8	33.9	31.3	26.9	23.9	22.6	21.4	20.3	19.3
26.0	18.8	17.4	16.6	15.7	14.1	13.3	16.7	21.3	24.8	27.4	29.6	31.1	32.1	32.9	33.3	33.3	32.6	29.9	26.5	24.1	23.3	20.8	20.1	18.6
27.0	17.7	17.0	16.6	15.7	15.5	14.3	17.2	20.5	24.1	27.5	30.1	32.0	33.3	34.0	34.5	34.5	34.0	32.4	27.1	22.8	21.6	20.9	19.7	18.4
28.0	17.0	16.0	16.5	16.5	14.6	14.1	16.5	20.4	24.6	27.6	30.1	32.8	33.9	34.8	35.4	34.8	33.5	30.7	27.2	24.1	22.1	22.7	22.5	20.3
29.0	20.2	20.2	19.8	19.4	17.1	16.4	16.4	18.6	20.1	20.9	21.2	22.3	22.5	21.7	21.3	21.1	20.7	19.9	18.5	17.0	16.5	16.1	15.3	16.4
30.0	16.6	15.5	14.3	13.8	13.7	12.8	15.4	19.1	20.6	22.4	23.6	24.2	23.7	23.8	22.8	21.9	21.3	20.7	19.6	17.7	16.2	15.7	15.2	14.7
31.0	14.0	13.7	13.8	13.4	13.5	14.0	15.0	15.7	17.4	19.4	20.9	21.0	22.1	23.2	23.6	23.7	23.3	23.0	22.1	21.4	21.4	20.0	17.8	17.3

September hourly temperatures for Gerber, CA 2000.

September, 2000 Gerber, CA for Hourly of Chilling at Red Bluff, CA. Temperature Summery in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1.0	16.5	16.2	16.0	15.9	15.7	15.6	15.8	15.6	15.6	16.4	16.5	16.0	16.7	18.2	18.4	18.1	17.9	16.9	15.7	15.4	14.9	14.3	14.1	14.3
2.0	14.1	13.8	13.6	12.5	12.8	13.4	14.2	15.3	16.7	18.4	19.4	20.5	21.2	21.4	20.7	20.8	20.2	19.9	17.9	16.8	15.2	15.7	16.6	15.7
3.0	14.7	14.2	13.8	13.5	13.3	13.1	13.9	15.4	16.8	19.2	21.2	22.0	22.9	23.6	23.8	23.8	22.9	21.8	19.0	18.0	17.9	18.2	15.9	14.4
4.0	14.2	14.8	15.0	14.5	14.4	13.9	15.3	16.8	17.9	19.2	20.4	21.6	22.9	23.3	23.4	23.9	22.0	21.7	18.7	16.0	14.7	14.2	13.4	13.0
5.0	12.5	12.4	11.7	11.4	11.1	11.0	12.2	14.6	17.5	19.9	21.6	23.2	24.3	25.2	25.9	26.2	26.1	25.2	23.0	20.8	19.9	18.8	17.6	17.4
6.0	16.2	14.7	14.1	14.8	15.3	15.7	17.5	19.5	21.6	23.4	25.2	27.0	28.5	29.8	30.5	30.7	30.6	29.4	26.3	24.2	23.0	21.2	20.4	19.4
7.0	18.4	17.7	16.9	16.7	15.6	15.9	17.3	20.3	23.0	25.1	27.6	29.5	31.0	32.4	32.8	32.7	31.5	29.7	25.4	21.0	18.9	17.1	15.5	15.0
8.0	14.0	13.4	12.6	11.9	12.4	13.0	15.1	17.9	21.7	25.4	27.2	28.9	29.6	30.0	30.3	30.4	29.1	26.9	25.5	21.6	20.7	22.0	21.5	18.8
9.0	18.1	17.6	14.8	13.6	13.0	12.1	14.8	19.0	21.1	23.4	25.6	27.7	29.1	29.7	30.0	30.1	29.5	27.2	23.2	21.0	18.6	17.8	16.1	16.3
10.0	15.0	14.0	13.2	12.7	11.7	12.5	14.9	17.7	21.2	25.2	26.8	28.4	30.0	31.2	31.6	31.7	30.5	29.4	25.2	21.9	20.3	19.7	17.7	16.3
11.0	16.0	15.4	15.7	15.6	14.1	14.2	16.3	19.5	22.8	26.2	28.8	30.6	32.5	33.7	34.0	34.1	32.2	28.4	24.7	21.7	20.1	18.7	16.6	16.1
12.0	16.2	16.3	16.3	16.2	16.0	15.1	16.2	19.3	22.7	25.8	28.9	31.9	33.3	33.8	34.1	31.7	29.8	27.1	24.1	22.3	21.7	21.8	20.1	19.7
13.0	21.1	21.9	21.3	21.7	22.0	20.8	20.7	22.2	24.1	26.2	29.1	32.1	32.7	32.9	32.5	31.4	32.5	26.9	23.2	21.3	20.6	19.6	17.8	17.4
14.0	21.5	24.6	24.8	24.0	23.2	22.0	22.0	23.7	23.6	23.8	24.1	25.0	25.5	27.2	26.9	29.1	28.5	26.8	23.6	22.2	20.4	20.8	21.5	20.2
15.0	19.9	19.4	18.3	17.3	15.6	14.7	15.9	19.0	20.6	22.7	24.5	25.8	26.8	27.6	28.1	28.2	27.8	25.5	21.6	20.0	19.0	18.4	17.6	16.9
16.0	16.0	15.6	15.5	14.1	13.1	13.1	14.9	18.9	20.7	23.0	25.5	27.1	29.3	30.6	30.9	31.9	31.1	29.6	25.5	23.8	22.1	21.8	21.5	21.1
17.0	21.2	19.8	19.4	19.7	19.1	18.6	20.2	23.2	26.1	28.4	30.3	32.1	33.6	34.8	35.5	35.9	35.5	33.9	31.7	29.4	28.7	27.7	27.1	26.7
18.0	26.1	25.5	24.6	24.2	23.0	22.8	23.6	26.3	29.0	31.7	34.2	36.2	37.4	38.1	38.5	38.6	38.2	36.5	33.4	30.7	27.6	29.0	26.8	26.1
19.0	26.1	25.5	24.6	24.2	23.0	22.6	23.6	26.3	29.0	31.7	34.2	36.2	37.4	38.1	38.5	38.6	38.2	36.5	33.4	30.7	27.6	29.0	26.8	26.1
20.0	25.8	24.9	25.6	24.4	23.5	23.8	23.9	27.1	29.4	31.3	32.8	33.8	35.2	36.9	36.8	35.9	33.8	30.3	27.3	24.1	24.2	23.8	21.8	20.5
21.0	21.9	22.0	20.0	18.5	18.2	16.8	16.3	17.5	19.3	20.8	22.0	22.9	23.9	24.6	25.0	24.8	24.4	22.9	21.5	20.7	20.3	19.5	18.8	18.4
22.0	17.7	17.5	17.3	17.1	17.0	16.9	17.2	18.4	18.3	18.6	19.0	19.5	19.9	20.7	20.9	20.7	21.1	20.2	18.0	17.0	16.1	14.6	14.9	13.8
23.0	13.6	13.2	13.1	12.5	12.6	12.1	13.0	15.3	17.5	19.5	21.0	22.2	23.4	24.3	25.3	26.1	25.9	23.8	20.7	18.8	14.8	15.3	14.4	13.5
24.0	11.8	12.9	11.8	10.0	8.9	8.5	9.8	13.9	18.7	20.8	23.3	25.1	26.7	27.9	28.2	27.6	27.0	23.6	20.5	18.3	16.6	16.4	14.2	13.9
25.0	13.9	14.8	14.3	13.7	12.8	13.2	13.9	16.5	19.9	23.0	26.3	28.6	30.5	31.4	31.8	31.4	30.4	27.7	21.7	18.9	17.3	16.3	14.6	14.6
26.0	14.5	14.9	14.7	14.7	14.0	13.2	14.3	17.3	20.3	23.2	26.6	29.3	30.7	31.2	31.3	31.3	30.4	28.7	22.2	19.4	18.3	16.7	16.7	15.7
27.0	16.1	16.4	15.9	14.5	14.1	14.2	15.2	18.0	21.2	24.3	27.1	28.0	30.5	31.2	30.8	30.0	28.2	25.2	22.6	20.7	20.5	20.6	19.5	18.3
28.0	15.7	14.3	13.7	13.5	12.4	11.7	11.8	15.3	17.8	18.9	21.1	23.0	24.5	26.5	27.3	27.7	26.4	22.1	19.6	17.5	16.4	15.8	14.8	15.2
29.0	15.1	14.8	15.3	14.1	15.6	14.8	16.0	19.7	23.6	26.9	29.4	31.1	32.3	33.3	34.0	33.8	33.5	31.7	29.6	27.8	27.0	27.0	26.1	24.6
30.0	22.5	21.3	21.9	21.2	20.0	18.6	17.8	21.6	25.2	28.5	30.6	32.5	34.4	35.3	35.8	35.6	35.0	32.5	27.6	25.0	23.9	22.5	20.2	18.9

October hourly temperatures for Gerber, CA for Red Bluff Nurseries 2000.

October, 2000 Gerber, CA for Hourly of Chilling at Red Bluff, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1.0	16.5	17.0	20.0	20.2	20.1	19.8	18.7	22.1	25.2	28.4	30.4	32.3	33.1	33.5	34.0	32.9	31.5	27.6	24.8	22.4	21.2	20.9	21.6	21.7
2.0	20.5	19.3	18.2	17.6	16.5	14.7	14.8	19.0	22.6	24.0	25.4	27.0	28.8	29.3	30.2	29.4	27.6	23.8	21.1	19.0	19.0	17.1	17.4	16.1
3.0	15.2	15.4	15.4	14.8	15.0	14.4	14.8	17.5	20.9	23.9	26.7	28.6	30.2	31.2	31.2	31.3	29.0	25.5	21.2	19.0	19.2	16.1	15.2	14.5
4.0	14.4	14.0	12.5	11.8	11.0	10.5	10.8	14.8	19.2	22.0	24.5	26.5	28.2	29.2	29.8	30.5	29.2	24.8	21.0	18.4	16.7	18.3	15.5	15.1
5.0	14.0	13.1	12.3	12.7	11.3	11.0	11.8	14.7	19.4	21.7	24.7	26.5	28.6	30.0	31.2	31.4	29.7	25.4	21.0	18.4	16.9	15.1	14.3	14.3
6.0	13.9	13.5	14.0	14.3	14.1	13.6	14.5	17.6	20.7	23.3	26.2	29.7	32.4	33.6	34.3	34.1	33.8	30.4	26.4	21.9	21.9	22.1	17.7	18.3
7.0	18.5	15.3	13.4	12.0	11.3	11.3	11.7	13.7	16.0	18.9	21.2	23.2	25.1	26.2	26.8	26.7	25.0	21.6	19.1	18.4	17.6	16.9	15.4	14.2
8.0	13.4	12.3	12.2	11.7	10.5	9.7	10.0	14.7	18.0	20.0	22.2	24.0	25.7	26.9	27.1	26.7	25.1	21.1	18.5	17.3	16.9	16.4	15.4	14.4
9.0	12.8	13.7	13.6	13.2	13.1	13.2	13.6	14.5	15.5	16.2	15.5	14.7	14.8	17.0	17.1	17.3	16.7	15.7	14.9	13.6	12.7	12.1	12.9	13.3
10.0	13.5	13.4	12.8	12.2	12.3	12.5	12.7	12.8	12.5	12.0	12.9	14.3	15.7	16.1	16.2	16.9	15.7	14.1	12.7	12.6	12.1	11.7	12.3	12.0
11.0	11.5	11.6	11.7	11.1	10.6	11.0	11.2	11.4	12.0	13.0	14.4	15.2	15.8	16.3	16.0	14.9	13.0	12.6	12.3	11.5	10.9	10.1	10.2	11.1
12.0	11.1	10.8	10.8	10.9	10.7	10.0	10.2	10.8	11.3	12.6	14.9	17.1	18.4	19.4	19.8	19.3	17.4	15.4	14.7	13.4	13.0	13.3	12.9	13.2
13.0	12.1	11.6	10.2	9.5	8.8	8.7	8.8	11.3	13.8	16.6	18.4	19.7	20.7	21.9	22.8	23.1	22.5	18.2	16.7	13.6	13.0	12.1	11.4	11.2
14.0	11.7	12.2	11.9	11.9	11.6	11.5	11.7	13.6	16.0	18.3	20.4	21.9	22.7	23.6	24.0	23.8	21.4	17.7	15.6	14.1	13.0	12.4	11.6	10.6
15.0	10.9	10.5	9.9	9.2	9.4	9.6	9.7	12.2	14.4	17.4	20.4	21.7	22.7	23.2	23.8	23.8	22.5	19.0	15.9	14.6	14.0	12.3	11.6	11.7
16.0	12.5	11.7	11.2	10.9	10.6	10.1	10.8	12.3	14.9	17.8	20.3	22.7	24.6	25.3	25.9	26.4	25.7	20.2	16.8	14.7	13.8	12.6	12.0	11.1
17.0	11.6	11.7	10.1	10.4	10.3	9.0	8.6	11.8	15.2	18.5	20.9	23.4	25.1	26.1	26.3	26.0	24.7	19.7	17.3	16.6	14.7	14.1	13.5	13.8
18.0	12.5	12.6	12.3	11.8	12.0	11.0	10.8	12.8	15.7	18.6	22.8	24.0	25.6	25.9	26.4	27.9	23.8	19.0	15.8	14.6	13.9	12.2	11.8	12.1
19.0	12.0	11.1	11.2	10.5	10.2	9.4	10.5	13.0	16.1	19.4	22.1	24.1	25.5	26.5	27.5	27.2	24.3	20.9	17.1	15.0	14.3	12.6	12.8	12.5
20.0	11.2	10.2	9.6	9.1	9.9	9.6	10.8	12.1	13.0	14.4	15.7	18.3	17.7	17.7	16.9	17.4	17.1	15.0	13.6	14.2	15.2	12.8	12.0	11.1
21.0	10.9	11.9	11.9	11.8	10.9	10.8	11.5	12.9	14.6	16.0	17.0	18.2	18.9	19.5	19.8	19.5	18.5	17.2	15.7	15.2	14.3	13.5	13.3	13.4
22.0	13.0	12.7	12.6	11.9	12.0	12.1	12.0	12.9	14.4	16.0	17.3	18.7	19.9	20.9	21.5	21.2	20.3	17.9	15.9	15.1	13.3	13.3	14.1	13.7
23.0	12.8	12.7	12.4	11.8	10.6	9.8	9.7	11.5	15.0	17.8	19.9	21.8	22.9	23.6	23.9	23.6	22.7	17.9	15.1	11.8	9.9	8.8	7.7	7.1
24.0	6.9	6.8	6.3	5.6	6.9	6.8	7.5	9.6	12.6	16.4	19.5	21.3	22.2	22.8	22.9	22.3	20.6	19.1	16.4	14.6	14.4	17.2	17.4	17.1
25.0	15.9	15.1	13.9	13.4	13.9	13.9	14.5	14.5	14.7	13.9	13.4	14.1	14.0	14.1	13.3	13.1	12.9	12.4	11.7	11.0	10.9	11.0	11.5	11.5
26.0	11.5	11.2	11.0	10.7	10.5	10.5	10.6	10.8	11.3	11.8	12.4	14.1	14.7	14.9	14.6	14.7	13.7	12.3	11.8	11.1	10.6	10.0	9.2	8.7
27.0	8.2	8.0	7.9	7.7	7.2	6.3	5.9	7.7	10.0	12.6	14.7	16.7	17.9	18.6	19.2	17.9	15.9	14.1	13.7	14.3	14.0	13.5	14.4	14.3
28.0	14.3	14.2	13.9	13.1	12.0	11.1	11.1	11.1	10.9	11.3	11.9	12.2	12.5	12.0	12.2	12.0	13.1	12.5	12.1	11.6	11.6	11.4	11.3	11.2
29.0	11.1	10.7	10.5	10.3	10.6	10.4	10.4	10.7	11.6	12.9	13.4	13.9	15.0	16.0	15.8	15.1	13.8	12.1	11.5	11.3	11.0	10.6	10.6	10.6
30.0	10.8	10.7	10.0	9.7	9.6	9.5	9.5	9.4	9.6	10.1	10.7	11.7	12.5	13.1	13.3	14.2	13.4	10.7	8.7	8.1	7.8	7.6	7.5	7.5
31.0	7.3	7.6	7.0	6.6	7.0	5.9	6.5	8.0	9.9	12.3	14.9	17.7	18.8	19.4	19.5	19.0	17.3	14.8	13.3	11.6	10.9	13.0	11.5	10.2

August hourly temperature data (°C) collected at Peace River, AB for Fairview and Manning, AB 2000.

PEACE RIVER, AB

AUGUST 2000

DRY BULB TEMPERATURE °C

	HOUR (Local Standard Time) MST																							
Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	20.8	20.1	19.4	19.5	17.5	16.6	16.5	16.3	16.6	17.1	17.2	16.4	14.6	15.4	14.6	14.5	14.9	14.6	14.8	15.3	15.0	14.9	14.9	14.6
2	13.1	13.8	13.8	13.9	13.4	12.8	13.4	14.2	14.6	15.4	16.2	17.6	18.3	18.8	19.9	19.7	18.7	19.4	19.9	18.6	18.1	17.6	15.1	15.2
3	15.1	14.9	14.4	14.9	14.6	14.7	15.1	15.3	15.8	16.7	17.9	18.7	19.7	20.1	20.8	21.1	22.1	18.9	19.9	20.2	19.1	18.2	15.8	15.2
4	13.5	13.7	12.7	11.9	10.8	12.2	11.2	13.0	13.8	15.5	17.7	20.3	21.9	23.0	23.7	24.0	24.1	24.6	23.9	23.2	21.8	18.2	18.0	16.8
5	16.2	16.8	14.9	13.6	12.8	12.4	13.5	15.2	17.6	19.6	21.4	22.8	23.8	25.0	26.1	26.5	27.0	26.9	26.8	26.1	24.9	22.2	20.7	18.1
6	16.1	15.6	15.6	14.9	16.0	15.5	15.3	16.3	16.4	16.3	17.0	16.7	18.4	20.1	20.7	21.5	22.8	22.4	21.4	20.6	18.9	16.5	15.0	13.2
7	11.7	12.1	12.2	13.1	12.6	12.3	12.3	13.3	13.5	12.5	12.6	12.9	13.5	14.6	14.9	15.9	16.4	16.4	16.0	15.7	15.3	14.8	14.2	13.7
8	13.5	13.4	13.1	12.9	12.2	10.9	10.6	10.7	11.2	12.3	13.1	13.3	14.5	16.3	14.8	14.6	15.2	15.1	15.1	15.5	13.3	11.2	11.1	11.0
9	11.4	11.3	11.0	10.6	10.8	10.6	10.7	10.7	11.3	12.4	14.2	15.0	16.1	16.3	15.7	14.9	14.6	14.6	14.6	15.0	14.4	13.1	11.4	12.8
10	11.1	9.6	8.0	6.7	9.4	7.4	9.8	10.0	10.7	12.3	12.0	12.1	12.7	13.1	13.2	13.8	13.5	13.5	13.2	12.5	12.4	12.0	11.4	10.8
11	9.6	9.4	8.7	8.7	8.2	8.0	8.1	7.8	7.9	8.1	8.0	8.5	9.0	10.1	9.5	9.9	10.2	10.4	10.5	10.0	9.6	7.1	7.1	5.3
12	4.2	4.0	3.3	3.3	3.2	2.4	3.7	4.4	6.2	8.1	10.8	13.3	15.6	15.8	17.6	17.6	18.6	18.8	18.5	17.5	15.4	14.0	12.8	12.0
13	10.2	8.4	7.7	8.3	9.1	9.4	9.5	9.6	9.3	8.5	8.8	9.6	10.8	11.1	10.7	10.2	12.1	13.0	13.1	13.1	9.9	8.3	8.1	8.6
14	8.9	8.6	8.6	8.3	8.1	7.8	6.7	7.7	9.6	11.8	13.1	14.8	16.3	18.2	18.9	19.4	19.8	20.0	19.9	19.3	17.3	15.5	14.4	11.3
15	11.0	10.9	10.1	9.2	9.1	7.3	8.6	10.2	12.3	15.4	15.9	17.2	18.3	18.5	16.6	14.9	15.1	15.0	14.1	12.9	11.7	10.6	10.2	10.1
16	9.8	9.3	9.0	8.8	6.5	8.5	8.3	8.2	8.7	9.0	9.4	10.2	10.6	11.5	12.3	13.2	13.6	13.8	13.8	13.5	12.3	12.0	11.7	11.7
17	10.2	9.6	9.4	9.7	9.8	9.2	9.0	9.9	11.2	12.8	13.5	13.7	14.5	15.1	15.9	16.8	16.8	17.1	16.8	18.2	14.8	14.0	13.2	13.0
18	12.3	11.5	10.6	9.0	8.0	8.4	8.8	9.0	10.6	12.4	14.7	17.8	18.8	18.6	18.7	19.0	14.8	16.2	16.2	16.6	14.5	12.5	10.9	9.8
19	8.9	8.7	8.4	7.9	7.6	7.5	7.8	7.8	9.9	12.3	12.4	14.0	14.7	15.5	15.5	17.0	16.3	16.5	16.4	13.8	12.3	10.9	10.9	10.6
20	8.2	8.0	7.2	6.8	6.5	6.4	5.7	6.9	10.4	13.0	14.2	15.8	17.0	16.6	18.0	17.0	16.7	17.4	15.0	15.3	11.7	8.6	8.8	7.5
21	7.2	7.3	6.2	7.3	5.5	5.6	5.9	7.4	10.9	13.1	13.6	14.2	15.8	17.4	18.1	17.8	18.7	18.2	17.1	16.0	13.9	13.2	13.0	12.7
22	10.9	10.2	11.4	9.7	10.1	11.7	10.7	12.1	15.1	16.7	18.2	18.2	20.0	20.8	21.2	19.8	21.8	21.8	20.7	18.3	17.5	16.3	15.3	13.8
23	11.2	10.2	10.2	10.0	8.7	7.3	9.0	10.0	13.0	16.4	18.0	19.4	20.8	21.6	21.1	22.0	22.5	22.2	22.1	20.5	16.0	14.7	13.5	14.7
24	15.3	13.1	11.8	11.0	10.3	10.2	9.5	10.4	12.4	14.9	15.9	17.1	18.8	19.4	20.0	20.6	20.9	20.2	20.5	17.6	17.0	16.2	15.9	15.8
25	15.7	13.0	11.9	11.3	11.9	11.6	10.8	11.6	13.6	14.9	14.5	14.7	16.0	17.9	19.6	20.2	21.1	21.2	21.5	19.8	17.2	12.7	12.9	11.8
26	12.0	11.1	10.0	9.8	8.9	8.0	6.3	6.5	9.8	12.1	13.5	14.7	14.1	16.4	16.0	16.8	16.1	15.2	12.3	11.8	10.3	9.8	9.4	8.0
27	7.6	6.6	6.5	6.2	6.5	8.3	6.4	6.9	7.4	7.7	7.9	8.8	9.6	10.8	11.6	11.1	9.8	9.2	9.8	9.5	9.8	9.3	7.7	4.8
28	4.1	5.1	4.5	2.1	2.6	2.2	3.0	4.5	5.7	6.9	8.7	10.0	11.3	12.4	12.9	13.2	13.1	13.1	12.2	11.4	10.8	9.7	9.1	8.9
29	8.7	8.1	7.8	7.7	7.2	7.0	6.8	6.5	6.9	7.3	7.5	8.3	8.8	9.5	9.8	10.3	11.3	10.1	9.5	8.4	7.8	6.4	6.3	5.8
30	4.1	2.2	1.9	0.6	0.0	-0.3	-0.8	-0.2	2.3	5.5	8.2	10.2	11.7	12.3	12.9	14.1	13.4	13.7	12.9	11.7	11.3	10.6	10.3	9.9
31	9.8	9.0	8.3	8.1	8.1	7.7	7.8	7.7	7.9	8.0	8.4	8.0	7.5	7.1	7.2	7.1	7.3	6.9	6.4	5.9	5.5	5.1	4.9	4.6

September hourly temperature (°C) data collected at Peace River, AB for Fairview and Manning, AB 2000.

PEACE RIVER A AB
DRY BULB TEMPERATURE °C

SEPTEMBER 2000

HOUR (Local Standard Time) MST

Day	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	4.2	3.6	3.4	3.0	2.9	2.8	3.0	3.4	3.7	3.8	4.9	5.3	5.6	5.9	6.3	7.0	7.3	7.5	7.8	8.0	8.2	8.5	8.7	8.8
2	8.8	8.8	8.6	8.6	8.4	8.4	8.1	8.2	8.3	8.2	8.4	9.1	10.0	9.8	9.4	9.8	9.5	9.5	9.5	9.7	9.3	9.2	8.7	8.7
3	8.8	8.1	8.1	8.6	8.6	8.3	7.9	7.9	8.3	8.9	9.6	11.5	13.3	13.1	12.5	12.5	11.3	11.2	10.8	9.4	9.5	9.1	9.0	8.5
4	8.2	7.4	7.1	7.1	6.9	6.6	6.0	6.7	7.3	7.5	8.4	9.2	9.7	10.1	11.0	11.3	11.7	11.9	11.8	10.4	10.8	9.4	9.1	9.5
5	7.4	5.9	6.6	7.3	7.5	7.6	7.3	8.0	12.2	13.5	14.1	16.3	17.7	18.2	19.0	14.3	14.0	15.1	15.2	10.9	8.9	10.0	10.0	9.6
6	9.3	6.4	6.6	6.2	4.3	5.2	2.1	4.2	8.4	8.8	10.6	12.8	13.8	15.4	15.7	17.4	17.3	17.1	16.4	13.1	10.9	8.8	8.9	9.3
7	9.7	8.0	7.0	7.5	8.4	7.7	7.7	6.7	8.4	12.5	12.9	15.3	15.5	15.8	16.6	16.2	16.8	14.1	13.6	11.6	10.2	8.5	8.6	8.8
8	7.0	5.9	5.4	6.1	5.0	3.9	4.4	4.4	6.6	8.8	10.2	10.6	11.5	12.0	13.0	13.5	13.3	13.2	12.3	10.3	8.4	7.6	7.2	7.7
9	7.4	7.2	6.2	5.1	3.4	2.9	3.5	4.8	4.8	5.4	7.7	8.7	9.2	10.7	8.4	10.1	10.2	10.8	9.7	7.7	7.4	7.0	6.7	6.2
10	6.6	6.9	5.9	4.7	4.7	4.7	3.2	3.5	4.1	5.1	6.3	6.4	8.5	9.6	10.3	11.1	10.5	11.1	10.3	8.4	5.5	4.7	3.0	3.4
11	7.7	7.0	4.9	5.1	2.1	2.7	1.4	1.0	4.4	7.3	8.7	9.6	9.5	8.7	8.6	8.8	9.2	10.2	10.0	8.0	8.0	10.3	9.8	9.1
12	9.2	8.6	7.9	7.0	7.4	7.5	7.6	7.6	8.8	9.5	12.5	13.4	14.7	15.0	15.6	15.3	15.1	14.7	14.4	12.0	11.5	9.8	10.1	9.9
13	7.6	5.5	3.6	3.3	3.3	2.8	2.3	2.7	5.3	6.6	9.0	11.1	12.8	14.0	14.9	15.7	15.7	15.4	13.8	12.5	11.1	9.2	8.8	9.7
14	10.9	10.3	8.6	8.3	8.0	7.4	9.0	9.2	9.4	11.9	13.3	16.7	20.1	21.4	20.7	21.7	22.1	20.8	19.8	16.3	16.6	14.6	14.3	13.5
15	10.8	10.1	7.7	8.8	10.0	12.5	12.0	11.8	12.8	13.8	15.3	16.6	17.3	17.2	17.0	17.2	17.3	16.7	16.0	13.0	11.9	8.2	3.8	4.5
16	4.0	3.8	3.3	3.7	6.2	6.3	6.8	7.3	7.7	8.2	9.7	11.9	12.4	15.6	18.2	18.8	18.4	18.1	17.7	16.6	16.3	15.2	15.0	13.1
17	12.7	13.3	13.0	13.1	13.5	13.4	12.9	12.0	13.1	16.4	17.8	18.6	19.4	20.4	20.4	21.7	21.0	21.5	19.3	16.8	11.8	11.6	13.9	14.9
18	14.1	12.4	11.1	8.9	7.5	8.4	9.6	9.3	10.4	10.2	11.6	13.2	16.3	17.1	16.4	16.5	17.3	15.4	13.8	11.6	12.0	12.8	12.5	11.2
19	8.4	8.2	8.8	8.8	8.5	7.6	7.1	7.9	8.0	7.3	8.3	8.4	8.2	10.0	11.3	11.7	12.7	12.6	9.8	7.4	6.3	4.8	4.5	4.7
20	4.3	4.6	5.0	4.1	3.8	3.8	3.4	3.0	3.2	4.4	4.1	4.6	4.6	4.9	6.3	6.0	6.1	6.1	5.2	2.1	2.8	1.9	0.9	1.2
21	1.1	0.0	0.3	-0.1	-0.1	-0.3	-0.5	-0.5	0.1	0.7	0.9	1.1	1.0	1.4	1.7	1.9	2.1	3.5	1.9	-1.0	-1.8	-1.8	-3.9	-3.7
22	-4.4	-4.8	-5.1	-5.8	-5.8	-5.5	-6.1	-5.9	-3.9	-1.7	0.4	2.0	4.1	5.6	7.0	7.7	8.8	9.4	8.4	5.8	4.5	2.6	1.2	3.0
23	1.2	-0.5	0.1	-0.6	-0.4	-0.3	0.3	0.5	3.6	8.2	9.8	13.3	16.6	13.5	17.2	16.4	17.0	17.1	14.7	13.1	9.4	5.9	5.7	4.3
24	6.1	7.5	6.2	4.6	4.1	4.5	3.7	2.2	5.1	8.0	10.6	12.3	14.1	15.7	17.6	18.4	18.9	18.8	15.5	12.7	10.2	8.8	10.8	8.4
25	7.2	6.0	5.9	6.1	6.1	4.6	7.0	6.7	6.7	7.3	7.4	7.4	7.6	7.6	7.9	7.6	7.7	6.4	5.8	5.3	5.1	4.5	3.9	3.6
26	3.4	3.5	3.2	3.2	3.2	3.3	3.2	3.2	3.1	3.2	3.6	4.1	4.4	5.1	6.1	7.5	9.1	9.3	8.5	7.7	4.7	5.9	3.9	3.3
27	2.6	1.7	1.1	0.2	-0.2	-0.9	0.7	0.2	1.6	5.3	9.6	12.1	15.0	17.6	18.4	20.0	19.2	17.1	15.7	11.6	7.3	8.0	6.1	6.0
28	7.2	10.2	11.0	11.7	10.0	8.5	9.7	10.7	10.0	13.5	15.6	16.1	17.1	17.6	18.1	18.4	17.9	18.2	15.3	12.8	12.6	11.6	9.9	6.4
29	8.4	6.9	8.7	8.3	9.1	9.0	8.7	8.4	9.2	9.9	12.8	15.0	16.8	18.0	19.1	18.3	17.0	17.6	16.0	12.2	11.2	10.2	7.0	7.0
30	6.9	8.0	6.3	6.5	7.7	9.9	8.5	8.1	7.5	7.3	8.5	8.9	8.6	4.1	5.2	5.9	5.7	5.8	4.9	3.6	3.8	3.2	2.1	2.0

August hourly temperature (°C) collected at High Level, AB for Fort Vermillion, AB 2000.

HIGH LEVEL A AB

AUGUST 2000

DRY BULB TEMPERATURE °C

HOUR (Local Standard Time) MST

Day	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	19.6	18.6	17.3	16.4	16.4	16.1	16.9	17.4	18.6	20.3	21.1	22.0	22.2	22.6	23.1	24.0	23.0	22.4	22.2	22.1	21.0	18.9	18.0	17.4
2	17.9	18.1	17.6	17.3	17.0	16.4	15.9	17.1	18.1	18.6	18.9	20.7	22.4	23.9	25.2	26.1	25.4	23.9	21.8	19.8	20.0	18.9	18.0	17.8
3	17.9	17.5	16.2	17.4	17.1	16.2	15.3	16.0	16.6	17.5	20.1	21.4	22.9	24.1	23.9	23.2	22.9	23.0	22.8	23.7	22.6	20.0	17.1	15.6
4	14.4	13.5	12.2	11.1	10.9	11.4	12.1	13.3	13.8	16.7	19.3	21.7	23.3	24.1	24.2	23.9	24.8	25.4	24.8	23.2	19.3	18.7	18.3	17.0
5	14.7	13.0	12.1	11.7	11.1	10.2	11.6	13.7	16.8	19.6	22.2	24.3	24.8	25.9	26.6	27.1	27.8	28.1	27.4	24.6	19.5	18.4	18.3	16.6
6	16.5	16.4	15.3	14.1	15.3	15.3	15.3	15.3	15.2	15.8	16.6	18.0	18.2	19.7	21.2	21.1	22.8	22.6	22.4	22.0	20.2	15.9	14.1	13.8
7	13.0	12.6	10.7	10.9	9.4	8.9	10.9	12.9	15.0	16.2	17.7	18.7	19.0	20.6	19.3	20.4	20.2	19.8	19.3	17.9	17.1	16.4	15.9	15.3
8	13.4	12.8	12.2	11.8	11.5	11.1	10.8	10.8	11.7	13.1	13.5	14.5	15.3	15.8	15.4	15.0	13.5	12.9	14.1	13.9	13.4	12.4	12.1	11.4
9	10.2	9.5	9.5	9.4	9.1	8.9	9.1	9.9	11.1	13.0	14.3	15.8	16.1	17.6	17.9	18.2	16.9	16.0	14.8	11.8	10.9	10.6	10.4	10.3
10	9.8	9.7	9.8	10.0	10.1	10.2	10.3	10.6	10.5	10.4	10.7	11.0	11.3	11.3	12.2	12.8	13.5	11.6	10.6	10.2	9.8	9.5	9.4	9.4
11	9.1	8.3	7.3	6.1	6.9	7.1	7.0	7.4	8.2	9.2	10.5	11.8	12.7	13.3	14.0	14.8	14.9	15.0	14.6	13.9	13.7	12.0	9.5	8.8
12	6.7	6.0	4.8	4.8	5.1	5.4	4.0	5.0	6.9	7.9	10.4	14.6	16.7	19.0	19.9	18.2	18.9	19.8	19.0	17.8	15.4	12.5	10.9	10.8
13	11.4	10.2	11.3	10.7	10.3	10.2	9.8	9.6	9.5	9.6	10.1	10.4	11.2	11.1	10.6	10.6	12.0	12.5	12.7	12.7	10.9	8.0	6.6	5.4
14	4.0	3.0	2.8	1.0	1.5	1.4	2.9	4.2	6.1	9.4	11.7	14.2	16.1	17.5	17.3	18.7	18.8	18.9	19.4	19.2	17.5	15.5	14.4	12.2
15	10.8	11.6	11.0	10.7	12.4	11.7	11.7	9.3	8.6	8.2	8.6	9.5	11.7	12.7	13.4	14.8	14.7	14.2	13.7	12.6	11.7	10.1	10.1	9.7
16	8.6	8.7	8.5	8.3	8.1	8.0	7.9	8.0	7.9	9.2	11.6	11.5	12.5	12.8	12.8	12.9	13.3	13.4	13.1	12.7	11.7	10.8	9.2	9.1
17	9.2	9.3	9.3	9.6	9.6	9.8	9.8	9.8	10.6	12.5	13.5	13.5	15.1	16.3	18.1	17.3	17.6	16.7	16.4	16.4	15.3	14.4	13.0	11.0
18	10.4	9.1	7.2	7.4	7.7	7.7	8.4	8.2	9.2	10.3	12.1	15.5	18.9	20.8	21.7	21.5	21.8	20.5	19.0	14.9	14.3	13.5	13.4	12.3
19	12.0	12.9	11.7	10.7	11.1	10.9	10.9	11.3	11.5	11.7	12.4	13.0	13.7	14.8	15.4	15.2	16.0	16.4	16.4	12.7	11.9	11.2	11.4	10.2
20	9.3	9.3	7.7	8.4	5.9	6.1	6.4	9.1	11.0	12.8	15.4	16.8	18.5	19.6	20.2	20.7	20.8	20.0	18.1	17.2	16.2	14.6	12.8	10.9
21	10.9	9.8	9.6	7.7	6.3	5.6	6.6	7.5	7.9	12.0	14.8	16.4	18.0	18.9	20.5	20.2	20.5	20.5	19.9	17.6	16.4	14.2	13.9	14.2
22	13.0	12.2	11.8	11.3	9.6	8.7	7.7	9.8	13.3	15.3	17.5	18.7	19.6	20.6	21.4	21.7	21.3	22.3	22.4	21.3	18.7	18.1	16.5	15.8
23	15.3	14.7	13.1	13.0	12.8	10.6	9.9	10.2	13.1	14.9	16.6	17.9	18.5	19.4	20.1	20.3	20.8	20.4	19.6	19.2	15.5	14.2	14.2	12.0
24	10.0	7.6	6.4	5.4	5.3	5.5	7.3	7.8	9.2	9.9	11.0	12.9	14.0	15.2	15.5	16.0	16.4	16.0	15.5	15.3	13.6	12.0	8.8	7.9
25	9.7	10.4	10.1	10.0	10.0	9.4	8.9	9.1	9.1	9.8	10.2	12.0	12.6	14.6	12.8	12.9	12.6	12.1	11.9	12.0	11.5	11.1	11.2	11.3
26	11.4	11.1	11.0	11.2	11.3	11.5	11.6	11.6	12.0	12.3	12.8	12.8	13.4	14.9	15.6	16.4	16.5	15.9	14.4	13.7	12.1	11.1	10.3	9.6
27	8.9	9.2	9.6	9.5	9.1	8.9	8.8	8.8	8.5	8.3	8.0	7.9	7.5	6.9	6.5	6.6	6.5	6.7	6.6	6.7	6.4	6.0	5.9	5.9
28	5.7	5.4	5.2	4.6	5.0	4.4	4.8	4.8	5.0	6.7	7.5	8.9	9.7	10.9	10.8	10.8	11.2	10.8	10.6	9.7	8.9	6.9	6.4	5.1
29	3.3	3.1	5.3	5.4	5.4	5.0	4.8	5.1	5.8	6.6	7.6	7.9	8.4	8.7	9.8	8.8	9.5	9.3	8.9	8.5	6.7	5.1	4.5	5.0
30	4.4	3.5	3.3	3.2	3.3	3.5	3.3	3.3	4.8	6.1	6.9	9.1	11.0	12.3	13.5	13.5	14.1	13.0	12.4	11.7	10.5	10.0	9.7	8.1
31	7.8	7.6	7.3	7.3	6.9	6.8	6.3	6.1	5.8	6.1	5.6	5.2	5.5	6.3	6.6	7.1	7.8	8.0	7.6	7.6	7.0	6.4	5.7	5.4

September hourly temperatures (°C) collected at High Level, AB for Fort Vermillion, AB 2000.

HIGH LEVEL A AB

DRY BULB TEMPERATURE °C

SEPTEMBER 2000

HOUR (Local Standard Time) MST

Day	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	5.1	4.8	4.4	4.3	4.2	3.7	3.7	3.5	3.6	3.5	3.8	5.0	7.2	10.5	10.7	10.7	11.2	11.8	12.1	12.4	12.0	11.2	10.9	10.3
2	10.0	9.8	9.2	8.5	8.5	8.3	9.3	9.2	9.3	8.9	8.8	9.1	9.9	11.0	11.5	12.0	12.0	11.8	11.7	11.7	11.5	11.4	11.6	11.3
3	11.5	11.3	10.5	10.1	9.8	9.5	9.3	9.4	10.5	11.7	12.9	13.8	13.9	14.5	15.7	16.6	16.4	16.6	14.1	14.2	10.5	8.0	6.0	5.4
4	3.9	3.1	1.4	1.2	1.7	0.9	0.6	2.4	5.5	7.8	9.9	12.1	14.3	15.4	16.2	16.4	16.5	15.7	14.2	12.8	11.6	10.6	10.2	9.0
5	7.0	6.2	5.9	5.8	5.9	5.7	5.5	6.0	6.9	7.7	9.2	11.0	14.2	16.5	17.8	17.3	15.8	14.7	14.2	10.8	9.9	9.9	10.0	9.9
6	9.1	8.6	8.4	7.8	7.8	6.7	5.4	7.4	7.0	10.4	12.3	13.6	15.1	16.1	16.8	17.1	17.2	17.2	16.7	15.2	12.3	11.6	10.8	7.8
7	7.1	7.6	7.2	7.2	6.2	5.4	4.4	4.8	7.0	10.5	14.8	16.3	16.9	18.6	17.7	16.6	13.8	13.8	14.8	13.5	12.5	11.0	9.3	7.2
8	6.5	5.0	4.8	3.6	3.4	3.0	1.9	2.3	3.8	6.8	10.2	13.6	15.3	15.9	16.7	16.6	17.0	16.4	14.5	12.8	12.4	11.8	11.1	9.5
9	7.7	5.7	5.8	5.1	6.0	4.5	3.5	4.8	6.7	9.5	10.1	11.7	11.4	13.5	12.8	13.8	13.1	12.8	12.1	10.6	7.8	6.4	5.1	4.4
10	4.4	4.4	4.0	4.2	4.3	3.9	3.4	3.3	3.6	4.3	5.2	6.1	8.1	9.5	10.9	11.0	10.8	9.9	10.1	7.2	6.4	2.8	2.0	1.1
11	0.0	-1.4	-2.0	-2.5	-3.3	-3.7	-4.4	-4.2	-0.3	2.7	6.5	9.4	10.2	11.2	12.4	11.8	11.3	9.4	9.4	8.7	8.0	5.8	2.7	3.0
12	3.7	4.5	4.0	4.2	4.2	3.9	3.5	3.0	5.1	7.9	10.5	12.3	13.3	14.8	15.1	15.4	16.7	16.6	11.9	10.6	10.6	9.0	8.1	6.1
13	5.8	4.4	2.7	0.6	-0.2	0.0	-1.3	-0.7	1.7	5.1	9.5	13.1	15.2	17.1	17.5	17.5	17.6	17.1	16.8	13.2	11.0	9.7	9.3	8.3
14	5.9	5.8	4.3	4.7	3.8	2.6	3.4	4.1	6.3	8.8	12.2	14.3	17.9	20.2	20.1	20.4	21.5	21.7	21.3	18.8	14.8	15.8	13.8	11.3
15	13.8	11.9	11.3	11.8	10.9	8.4	10.2	8.5	8.6	12.2	13.3	14.4	14.8	15.5	16.6	16.7	16.6	16.8	16.0	13.7	12.4	10.6	8.4	7.9
16	6.7	5.8	4.5	5.6	5.5	5.7	5.7	7.0	7.1	7.7	8.4	9.1	10.6	11.7	12.8	12.4	11.4	10.6	9.1	8.7	8.6	8.4	8.2	8.2
17	8.4	8.4	8.2	8.0	8.0	7.8	7.8	7.8	8.0	8.2	8.6	9.4	9.8	10.1	10.5	11.2	12.3	12.5	11.8	11.9	11.2	11.5	11.9	11.4
18	11.2	11.3	11.5	10.7	10.9	10.8	10.2	9.5	10.0	9.6	9.9	10.6	11.8	12.8	13.8	11.6	10.9	11.8	11.7	11.2	9.8	7.6	6.1	8.1
19	8.2	7.8	8.4	7.0	6.2	5.7	5.0	4.4	4.2	4.4	4.8	4.6	6.4	7.0	8.3	8.7	9.5	9.2	8.6	6.7	4.5	3.0	1.3	2.8
20	1.9	1.4	1.1	0.8	0.2	-0.1	0.3	0.2	0.7	1.9	3.0	5.2	5.5	5.3	6.6	5.8	6.2	5.1	4.3	3.3	1.6	-0.1	1.0	1.0
21	1.1	1.3	1.3	0.9	0.5	-2.1	-2.9	-2.8	-0.7	0.5	2.2	3.5	3.9	5.4	5.5	6.5	6.3	6.5	5.5	3.8	0.6	0.1	0.1	-1.1
22	-1.9	-3.6	-3.8	-3.8	-4.7	-2.6	-2.1	-1.9	-0.8	1.4	3.0	4.1	5.5	7.3	7.9	9.3	9.4	8.5	8.0	5.8	5.1	4.5	2.1	1.2
23	-0.1	-0.2	-0.3	0.1	0.2	0.8	0.9	1.0	9.7	9.5	11.0	13.2	14.0	14.7	15.6	15.6	16.4	15.9	15.0	13.0	10.9	11.7	11.3	10.5
24	9.6	9.3	9.1	9.0	7.4	6.3	6.9	5.7	6.9	7.4	8.8	11.7	12.1	12.7	12.4	12.6	12.2	12.0	10.6	9.8	7.9	7.0	6.5	5.8
25	4.9	4.9	4.9	3.3	3.0	2.4	2.3	1.6	0.9	1.2	1.5	2.2	2.3	2.4	3.0	2.8	3.0	3.3	3.2	2.6	2.0	2.0	1.6	1.4
26	1.1	0.8	0.6	0.9	0.9	0.2	-0.5	-0.7	-0.7	-0.6	-0.5	0.0	0.4	0.8	1.0	1.5	1.2	1.1	0.9	0.8	0.7	0.8	0.9	1.0
27	1.0	1.0	1.1	1.2	1.1	1.0	1.0	1.0	1.1	1.7	2.1	3.2	4.2	5.0	5.7	6.6	6.9	7.3	7.2	7.0	5.9	6.1	5.4	5.5
28	5.2	4.8	4.7	4.6	4.7	4.5	4.3	4.4	4.4	4.6	5.5	6.5	6.7	6.7	6.9	6.8	6.6	6.6	6.5	6.3	6.2	6.2	5.9	5.4
29	5.1	4.5	4.4	4.6	4.6	4.8	4.7	4.5	4.3	4.2	4.1	4.4	5.1	6.0	6.2	6.6	7.1	6.6	6.2	6.1	6.1	6.0	5.5	5.4
30	5.2	5.0	5.0	5.0	4.7	4.6	4.6	4.5	4.5	4.9	5.2	5.6	4.1	3.8	1.5	1.1	0.9	1.3	1.3	1.5	1.1	1.2	1.3	1.1

Table 1.2 Hourly dry bulb air temperatures at La Ronge, Saskatchewan Canada for August 1998.

August, 1998 La Ronge Hourly Temperature Summary - Dry Bulb Air Temperature (0.1°C)

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	195	185	152	146	138	139	142	168	196	200	204	216	227	234	248	267	271	273	271	265	252	232	219	219
2	211	201	202	193	180	174	182	195	207	217	230	245	258	268	272	276	268	272	274	260	248	220	199	177
3	160	150	135	134	133	123	152	170	209	229	255	278	289	298	305	278	281	279	272	273	257	230	221	209
4	203	180	180	155	145	136	159	190	217	254	279	300	305	311	310	320	315	311	303	295	82	259	257	232
5	225	224	222	218	219	208	204	206	223	240	261	259	282	317	331	348	345	343	338	324	285	281	265	241
6	235	225	218	218	213	217	214	219	230	254	278	304	318	334	335	349	330	328	313	291	278	247	230	208
7	171	187	184	164	132	112	108	152	187	213	232	241	250	268	273	277	284	272	272	255	242	201	175	183
8	178	170	171	164	158	164	162	170	171	173	189	201	216	238	248	256	262	260	258	253	240	211	192	186
9	175	144	128	140	118	108	98	114	149	188	215	233	243	247	256	278	275	273	268	255	230	214	186	187
10	193	193	189	175	163	178	180	163	194	215	226	255	274	287	291	297	294	293	289	276	265	251	242	231
11	227	222	223	205	205	187	180	190	215	213	219	226	246	257	265	276	289	293	280	272	258	225	193	199
12	212	196	183	175	157	156	157	159	182	211	224	228	225	218	202	220	240	255	255	258	230	183	166	157
13	156	161	154	155	147	156	148	151	154	163	165	161	160	156	171	174	175	171	176	148	149	150	144	126
14	102	102	94	106	98	95	93	103	130	157	172	189	185	191	207	214	212	215	208	196	186	169	162	158
15	143	143	138	131	119	130	153	157	149	145	153	153	153	151	146	153	156	155	159	155	146	136	133	112
16	116	119	111	118	119	121	119	124	138	134	142	144	144	146	156	160	163	164	163	163	157	151	153	147
17	144	143	142	138	134	127	130	139	142	155	169	170	200	209	215	212	228	220	217	212	201	190	182	175
18	169	165	166	168	166	158	157	155	158	170	182	189	202	216	220	227	226	243	239	243	218	189	152	145
19	124	112	101	95	125	126	138	154	153	181	196	213	225	226	215	197	194	194	191	175	171	153	146	123
20	120	79	66*	54*	50*	40*	40*	58*	87	131	143	147	166	149	149	152	153	159	161	155	145	111	111	102
21	82	84	130	134	122	128	101	121	163	179	192	211	221	240	238	238	240	239	233	226	221	211	189	189
22	183	184	186	179	160	161	165	174	180	189	200	204	215	228	228	229	246	228	222	209	186	184	173	164
23	164	157	153	142	143	136	136	137	156	183	204	217	225	232	239	244	252	248	245	233	207	167	135	117
24	113	120	130	135	129	128	110	144	147	169	193	222	232	244	218	215	242	194	209	72	157	134	133	119
25	121	118	107	99	93	87	76	96	124	153	169	183	193	213	208	213	218	218	213	196	172	131	122	101
26	97	93	78	87	80	132	147	155	159	170	175	205	221	236	236	234	225	202	193	191	192	153	150	143
27	135	137	137	131	121	111	108	119	126	142	151	153	175	195	208	216	214	209	208	201	195	171	164	187
28	154	154	147	144	150	139	134	131	146	160	176	190	201	209	218	218	221	216	215	204	188	168	153	125
29	119	109	93	84	68*	65*	56*	78	131	166	189	204	222	235	244	250	251	242	232	219	198	180	175	169
30	172	170	157	142	148	129	123	112	170	197	236	251	276	261	244	244	242	263	261	251	226	218	206	186
31	174	166	147	127	123	129	123	122	131	144	154	165	176	175	178	188	186	180	171	157	146	129	109	93

Table 1.3 Hourly dry bulb air temperatures at La Ronge, Saskatchewan Canada for September, 1998.

September, 1998 La Ronge Hourly Temperature Summary - Dry Bulb Air Temperature (0.1°C).

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	84	86	72	74	62	48"	51"	55"	85	113	131	139	153	159	168	171	174	179	163	156	135	120	119	133
2	144	137	136	135	135	137	131	135	145	151	161	172	185	200	210	221	215	226	210	204	195	182	172	169
3	166	156	146	140	157	157	160	156	157	166	179	202	209	216	216	222	224	216	211	193	155	121	94	84
4	68"	62"	59	70"	51"	58"	78	83	121	141	139	133	153	177	206	194	206	198	193	182	157	135	106	84
5	111	111	105	93	91	84	74	77	104	131	156	177	185	193	193	190	202	139	184	177	160	136	121	97
6	82	74	69"	60"	73	63"	49"	58"	96	127	142	149	163	178	174	186	189	188	179	156	127	92	105	130
7	135	129	127	124	120	113	112	117	125	132	145	162	169	183	207	203	211	209	202	188	177	171	168	167
8	158	152	149	148	147	149	147	145	141	144	146	157	158	165	159	164	186	184	182	175	164	152	129	107
9	98	90	95	96	98	108	116	117	119	120	126	136	147	168	186	205	20	206	196	182	172	165	147	142
10	139	136	135	130	131	132	132	132	132	139	151	166	171	182	192	199	192	190	192	171	134	128	132	132
11	121	115	115	108	93	88	82	82	105	123	143	171	175	187	196	205	203	195	186	178	178	174	167	165
12	152	152	151	143	136	130	119	110	127	146	159	184	187	202	202	212	218	211	205	183	138	106	99	84
13	94	125	132	129	135	134	139	142	155	174	177	182	179	182	208	203	190	184	189	181	162	152	140	128
14	113	103	107	102	93	92	106	84	97	101	124	136	133	140	134	152	146	142	143	122	111	79	69"	56
15	69"	81	82	86	84	108	115	121	122	130	144	151	169	180	198	196	195	184	176	173	141	116	111	99
16	98	88	85	75	72	69"	76	80	97	103	102	102	114	122	141	147	142	136	130	130	130	127	126	125
17	121	101	100	104	100	84	87	87	89	98	106	115	120	118	121	129	131	125	117	95	63"	27"	6"	-12
18	-15	-18	-20	-24	-32	-25	-10	-27	11"	69"	83	94	106	103	115	127	131	136	131	117	108	107	93	88
19	84	88	88	78	84	84	30	86	95	97	106	117	117	120	126	128	130	134	135	117	69"	44"	25"	19"
20	9"	8"	1"	-5	-6	-9	-19	-26	27"	68"	107	134	146	148	150	146	147	149	141	122	110	408	103	98
21	94	86	85	80	75	72	68"	51"	62"	77	100	128	135	157	166	170	171	171	162	144	137	126	109	104
22	104	89	77	75	83	82	67"	61"	74	99	125	129	158	180	190	197	195	184	172	151	124	113	101	100
23	77	45"	35"	26"	39"	33"	16"	24"	51"	79	103	126	135	142	140	143	145	148	138	113	94	98	113	113
24	106	105	107	83	86	89	87	70"	68"	102	109	118	129	119	117	93	84	86	84	77	69"	65"	62"	68"
25	44"	19"	7"	-7	-14	-16	-4	-24	-5	58"	73	80	91	102	97	112	114	111	104	79	32"	17"	79	72
26	70"	63"	55"	59"	48"	55"	60"	60"	48"	58"	71	72	78	81	85	85	95	92	91	72	65"	67"	80	84
27	82	77	55"	74	73	69"	60"	50"	62"	84	101	118	129	135	137	139	141	134	113	88	83	83	73	78
28	80	77	78	78	77	77	61"	65"	65"	70"	80	83	85	98	97	96	93	104	93	84	67"	66"	57"	38"
29	29"	18"	26"	47"	51"	51"	52"	47"	48"	56"	55"	66"	76	81	84	89	83	83	72	54"	49"	39"	36"	9"
30	43"	43"	38"	39"	40"	40"	35"	36"	37"	48"	49"	54"	58"	73	82	91	88	87	73	49"	14"	-10	-7	8"

Table 1. 1

August, 1998 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	19.0	18.0	19.0	19.0	17.9	18.9	21.5	24.3	27.2	29.8	32.5	34.4	35.6	36.6	37.3	37.6	37.6	37.5	35.2	27.0	22.2	21.2	19.9	18.4
2	18.1	18.3	19.0	19.3	17.2	15.8	20.2	24.9	28.2	29.6	32.1	33.6	35.6	37.0	38.6	39.8	39.6	37.4	34.8	29.0	24.9	23.2	22.5	22.6
3	23.2	23.5	23.0	21.7	22.6	22.6	24.6	27.5	30.4	33.0	36.2	37.7	39.1	40.8	41.4	41.7	41.1	39.0	34.9	29.8	25.5	24.3	22.9	21.5
4	20.7	20.4	19.2	19.6	20.5	18.9	22.9	27.6	31.0	34.4	35.5	36.7	38.0	39.0	39.4	39.9	40.1	38.7	35.3	28.6	25.8	24.8	23.7	22.9
5	21.6	21.2	20.0	20.7	20.3	20.2	24.4	27.2	30.7	34.2	36.2	37.7	38.3	38.8	38.8	38.3	37.6	37.1	34.3	28.8	27.1	27.3	25.0	25.3
6	24.4	23.0	22.8	22.6	21.7	21.4	24.8	28.6	31.1	33.8	35.2	36.4	35.5	35.5	35.6	35.6	35.0	34.1	31.4	27.1	26.4	26.7	25.6	22.5
7	20.0	19.6	18.1	17.2	16.5	16.6	21.0	23.4	26.3	29.5	31.2	32.5	33.5	33.7	33.5	33.0	32.2	31.5	28.8	24.0	21.3	21.7	20.9	19.6
8	19.2	17.5	16.8	15.3	14.8	15.2	19.4	23.1	25.1	27.1	28.8	29.7	30.9	31.5	31.7	31.2	30.6	29.7	26.7	24.3	19.9	20.3	19.5	18.3
9	17.6	16.7	16.4	15.4	15.0	14.8	18.4	22.0	25.5	28.3	30.5	31.9	32.4	32.7	33.0	33.0	32.7	32.0	28.7	22.7	20.4	19.3	17.5	16.7
10	16.4	16.2	17.0	15.6	15.6	16.1	19.2	22.7	26.2	28.8	31.7	34.2	35.9	36.6	36.9	36.1	35.7	34.1	30.3	24.1	22.0	20.7	18.6	18.1
11	16.8	17.3	17.0	16.2	17.3	17.6	20.2	23.5	27.0	30.9	33.2	35.4	37.6	38.1	38.8	39.0	38.3	36.1	32.1	26.4	23.7	21.9	21.2	19.6
12	19.1	19.0	18.2	18.0	18.0	17.9	21.8	26.5	29.8	32.3	34.7	36.7	38.7	40.3	40.6	39.5	37.4	34.8	31.4	27.0	24.7	23.7	23.0	22.1
13	21.5	22.2	22.2	21.6	20.2	21.3	24.1	27.4	30.2	33.1	35.8	38.3	39.3	38.9	38.2	38.2	37.4	35.3	32.0	27.6	25.8	25.9	25.5	23.9
14	24.2	23.6	22.6	21.6	21.5	21.2	24.6	28.2	30.6	32.7	34.9	37.1	36.9	36.6	36.8	36.6	36.1	35.0	32.8	27.6	25.3	26.1	25.9	23.1
15	22.4	21.9	21.6	20.6	20.1	19.6	22.9	24.7	27.5	29.9	31.5	32.7	33.9	34.8	34.4	33.7	33.0	31.7	28.5	24.5	24.1	23.8	24.1	22.4
16	20.4	19.2	18.5	18.2	16.8	17.0	20.5	23.9	25.5	27.8	29.1	30.6	31.6	32.2	32.3	31.9	30.9	29.5	26.9	23.9	22.6	21.4	20.9	20.9
17	19.7	18.8	18.0	17.2	16.6	16.1	17.9	20.1	22.0	24.2	26.2	27.7	28.7	29.1	28.9	28.7	27.4	26.1	24.3	21.0	19.9	19.8	19.3	18.4
18	17.6	16.8	15.7	14.6	14.3	14.5	15.6	18.2	20.5	22.5	24.3	26.0	27.3	28.0	28.8	28.7	27.6	26.3	22.9	19.7	18.7	17.4	16.6	16.3
19	15.7	15.2	14.7	14.2	13.4	13.3	15.4	18.5	20.8	23.6	25.8	27.5	29.0	30.1	30.6	30.5	29.4	27.6	23.8	20.5	18.5	17.5	17.0	16.5
20	15.9	15.7	15.7	14.7	14.2	13.6	15.0	18.2	20.2	22.9	25.4	27.4	28.8	29.6	30.1	29.6	29.0	27.6	24.1	19.1	17.6	17.2	15.8	14.9
21	14.5	13.3	12.7	12.4	12.4	11.9	15.1	18.5	21.8	24.8	26.9	28.6	30.5	31.4	32.2	32.1	31.5	30.0	26.6	20.8	19.1	17.6	16.2	14.6
22	13.9	13.3	13.4	13.5	13.2	13.3	15.9	19.8	23.2	26.7	28.7	31.0	32.6	33.4	33.4	33.0	32.2	30.1	26.2	22.8	22.5	19.7	18.7	18.0
23	17.3	16.5	15.6	17.0	14.7	13.8	16.8	20.8	22.8	25.6	28.0	30.2	32.1	33.4	34.2	35.0	35.7	33.0	29.4	22.7	19.3	17.9	17.2	15.8
24	15.6	14.5	13.9	13.3	12.5	12.2	16.2	20.8	24.7	28.6	30.0	32.2	33.6	34.3	34.5	34.1	33.0	30.8	26.9	23.4	20.1	19.6	18.1	17.7
25	17.0	16.8	15.7	15.8	13.8	13.1	16.6	21.2	25.0	27.3	29.2	30.8	31.1	31.4	31.5	31.0	30.4	28.9	25.3	20.8	18.1	17.6	18.6	16.1
26	15.0	14.0	14.1	13.1	13.1	12.7	15.0	20.1	21.3	25.0	27.1	29.6	31.7	32.5	33.5	33.3	33.3	31.5	25.6	21.3	19.0	16.8	16.1	15.1
27	14.3	13.8	13.8	14.6	14.9	15.2	17.1	20.2	24.4	27.7	29.6	31.3	32.9	34.1	34.7	34.7	33.7	31.2	27.4	22.0	19.5	18.1	16.8	16.0
28	15.1	14.6	14.8	15.4	14.8	14.8	17.1	21.4	25.2	28.8	31.6	34.4	35.3	36.2	36.5	36.0	34.8	33.6	29.5	22.9	21.1	19.5	18.3	17.9
29	17.5	18.0	18.5	18.0	16.9	17.0	19.0	22.7	26.5	29.6	31.8	34.5	37.1	37.4	37.8	37.2	37.2	35.5	29.0	24.5	23.9	22.5	21.5	20.9
30	19.9	19.2	19.0	19.5	18.7	17.1	19.6	24.1	27.8	30.8	33.4	35.1	36.0	37.3	37.2	37.4	37.6	35.3	29.3	23.9	21.0	19.7	19.1	18.8
31	20.0	19.0	19.8	19.7	18.6	18.7	21.8	25.0	28.3	31.6	34.6	37.2	39.5	40.4	41.9	41.7	41.9	40.3	34.2	27.5	24.4	23.4	21.9	20.2

Table 1. 2

September, 1998 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	20.7	18.9	18.2	17.2	16.8	16.2	18.5	23.2	27.3	30.6	33.6	36.6	38.3	40.2	40.2	40.9	40.7	39.4	32.2	27.0	24.4	24.0	22.7	21.7
2	20.4	20.1	18.7	18.0	17.6	16.7	19.4	25.0	27.6	30.2	32.2	34.5	36.6	37.7	39.8	41.0	41.4	39.4	31.6	26.8	25.1	22.8	23.1	25.4
3	25.2	23.0	21.1	20.4	20.4	20.5	22.1	25.5	29.5	32.6	34.4	36.0	38.2	38.8	38.4	37.2	35.8	33.1	29.8	27.1	25.0	24.0	23.0	22.3
4	23.5	23.2	23.6	23.1	23.1	22.7	24.0	27.0	29.6	31.5	32.4	33.6	34.0	34.7	34.9	34.5	33.4	31.5	30.1	29.6	28.9	28.5	26.8	26.0
5	24.4	23.7	22.8	21.9	21.6	21.7	21.5	22.1	23.5	24.9	26.3	27.4	27.5	27.6	28.0	28.3	29.1	27.5	25.0	24.0	23.4	23.1	22.7	22.0
6	21.5	21.8	22.3	22.6	23.0	22.9	22.7	25.0	27.1	29.1	29.4	31.5	33.5	34.0	33.8	34.1	31.2	30.9	29.7	26.4	24.7	24.4	23.6	23.3
7	23.1	22.6	22.0	21.4	20.9	20.6	22.3	25.3	28.8	31.0	32.4	33.1	33.8	33.8	35.0	32.5	30.8	30.5	28.4	27.1	26.5	25.3	24.9	24.5
8	24.0	21.5	19.8	19.0	19.3	18.6	20.9	24.3	25.7	28.2	29.7	30.9	31.5	31.7	32.1	31.9	31.1	29.2	26.6	26.4	25.3	24.6	23.0	21.1
9	21.1	20.2	19.3	18.5	17.1	16.3	16.4	17.7	18.6	19.3	20.4	21.7	22.8	23.2	23.9	24.2	23.8	20.9	17.6	16.7	16.6	15.3	16.2	15.9
10	13.7	13.7	12.4	12.7	12.6	12.8	14.1	16.8	19.6	22.0	24.6	26.7	28.1	29.0	29.7	30.0	29.8	28.6	25.2	22.0	21.7	20.0	18.8	18.1
11	17.8	18.4	18.5	18.1	18.6	18.8	20.7	23.0	25.3	27.6	29.4	30.8	31.6	32.6	33.5	33.8	33.6	32.7	29.1	27.0	24.5	25.3	23.1	20.5
12	19.4	17.6	16.6	15.8	15.7	17.0	18.4	23.4	26.4	29.4	31.6	33.3	34.5	35.0	35.4	35.4	35.2	33.2	27.9	26.0	24.5	22.5	23.4	23.4
13	22.7	21.8	21.5	20.6	20.4	20.2	21.3	24.1	27.1	29.8	32.4	34.6	36.1	37.2	38.1	38.5	37.5	35.1	28.8	24.6	22.0	22.9	21.2	19.3
14	18.3	17.6	18.2	18.3	18.2	18.2	20.0	23.2	26.5	28.8	30.7	33.0	34.9	34.6	34.8	34.7	33.7	31.3	26.0	23.6	22.7	21.8	20.9	19.9
15	19.9	20.1	20.5	20.4	19.1	19.3	21.0	22.3	25.4	29.5	32.0	32.8	33.7	33.9	33.9	33.4	33.3	31.4	26.0	23.2	22.6	22.0	20.8	19.7
16	19.2	17.8	17.2	16.3	16.5	15.6	17.0	21.6	24.4	26.6	28.8	30.3	31.1	31.6	32.3	32.4	31.7	29.1	24.5	22.0	20.7	20.2	20.6	21.5
17	22.1	20.1	18.6	17.8	15.2	14.0	14.8	18.6	20.4	22.6	24.4	25.7	27.0	28.4	28.8	28.6	27.8	26.2	24.1	20.4	17.8	17.5	17.7	18.2
18	16.7	15.2	13.7	12.9	12.4	12.9	15.1	17.1	19.9	21.5	23.2	24.1	25.2	26.0	26.7	27.1	26.8	25.3	22.4	21.7	21.4	18.8	18.2	16.1
19	17.5	18.0	18.0	17.9	18.3	18.3	18.7	20.4	21.9	23.2	24.7	26.1	26.6	27.7	28.2	27.9	27.5	26.5	24.7	24.4	23.0	23.2	22.5	21.8
20	21.4	20.5	19.7	19.1	18.1	18.0	18.8	21.0	22.5	24.2	25.7	27.4	28.8	29.8	30.1	30.2	29.6	27.2	21.2	19.4	17.5	16.6	15.0	14.6
21	14.7	14.1	12.4	11.5	11.3	10.8	12.1	17.2	19.3	22.0	24.2	26.1	28.4	29.8	30.0	29.9	28.2	24.6	20.5	18.5	18.3	16.2	14.6	14.4
22	13.9	13.3	13.3	12.0	11.2	11.8	13.1	15.9	18.3	20.3	22.3	23.9	25.1	25.9	26.1	25.9	25.1	22.3	18.9	17.6	17.2	17.2	16.8	15.9
23	14.6	14.1	15.0	13.1	12.8	12.5	12.5	14.2	17.5	20.9	22.5	23.4	24.8	24.9	24.5	24.4	23.5	21.3	19.2	18.9	16.7	15.7	15.0	14.6
24	14.1	13.7	12.9	12.1	11.5	10.6	11.4	16.1	17.9	19.7	21.7	23.2	24.3	25.1	25.4	25.0	24.1	22.4	19.8	18.6	17.3	17.0	16.6	15.4
25	14.7	15.3	15.4	15.0	14.8	14.5	14.1	14.2	15.1	15.9	17.6	19.1	20.1	20.5	20.5	20.2	20.0	19.2	18.4	17.9	17.6	17.2	16.6	16.4
26	15.8	15.2	13.9	13.2	13.6	12.6	12.3	13.0	14.0	17.4	19.2	22.0	23.5	24.0	24.0	23.0	20.0	18.4	15.4	14.1	13.1	12.6	12.2	11.2
27	10.3	10.7	10.1	9.0	8.8	9.3	10.7	12.2	13.2	13.7	14.2	15.1	15.8	16.9	17.5	17.4	16.9	15.9	14.6	14.0	13.6	12.8	12.5	11.7
28	11.4	10.8	10.8	10.2	9.6	9.3	9.8	12.5	15.7	18.7	21.0	22.7	24.3	25.5	26.0	26.4	25.2	21.7	18.4	17.1	15.9	15.1	13.7	12.4
29	12.1	11.9	11.2	12.1	12.5	12.6	13.4	16.5	19.4	22.0	24.7	25.8	25.5	25.8	25.7	25.4	24.2	22.4	20.7	19.1	17.6	17.2	14.2	14.3
30	13.1	13.0	12.9	12.7	11.7	10.9	11.6	14.3	16.6	18.9	21.0	22.8	23.9	24.4	24.6	24.6	23.5	21.1	18.1	17.2	17.2	16.4	14.7	14.9

Table 1. 3

October, 1998 Gerber, CA for Hourly of Chilling at Redding, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	14.5	13.9	13.8	13.7	14.1	12.8	12.5	14.7	16.4	18.1	20.1	21.8	22.6	22.8	23.5	22.4	21.9	20.3	18.3	17.5	15.8	15.1	14.4	14.3
2	13.4	12.3	11.4	11.0	11.4	11.8	12.3	13.2	14.0	15.6	17.7	18.9	20.3	21.2	21.8	21.3	20.3	18.1	15.9	14.1	14.1	13.7	14.3	14.3
3	14.3	14.1	14.9	14.8	12.0	10.8	10.5	13.4	17.2	18.5	20.0	20.8	21.7	22.6	22.9	22.6	21.0	17.6	14.7	13.1	11.6	11.1	10.3	9.4
4	9.1	8.6	8.3	9.1	8.7	8.3	9.4	11.9	14.9	17.7	20.7	22.1	22.7	23.6	24.3	24.8	24.4	22.7	20.9	19.8	18.7	16.3	16.0	15.1
5	14.2	14.8	12.8	12.6	12.8	13.4	13.8	16.7	19.7	21.9	23.9	25.7	27.1	28.4	29.2	29.8	29.2	25.8	22.1	21.5	20.2	17.1	16.8	15.1
6									Harvesting Occurred															
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Table 1. 4 August, 1999 La Ronge Hourly Temperature Summary – Dry Bulb Air Temperature (0.1°C)

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	106	106	107	106	107	107	109	115	125	134	140	143	150	140	133	157	166	180	165	182	178	150	116	107
2	115	122	124	123	125	127	129	135	143	158	181	194	201	211	212	211	216	214	210	218	207	182	162	152
3	148	142	138	144	152	144	135	144	161	168	179	193	220	239	254	265	266	271	268	264	248	221	174	181
4	166	138	130	138	126	110	110	145	180	218	238	252	260	268	276	279	263	265	261	260	240	232	219	214
5	196	175	166	175	180	174	166	176	178	190	194	207	217	201	226	235	243	246	238	226	207	201	194	184
6	182	177	166	169	171	164	164	169	175	173	176	181	190	182	175	178	159	161	171	168	160	144	130	124
7	90	94	59*	61*	44*	34*	45	83	120	140	149	159	170	182	198	200	192	196	196	192	179	172	169	167
8	161	156	142	143	147	148	144	151	164	175	186	193	207	201	200	190	190	196	193	184	180	177	174	172
9	165	162	158		154	152	152	156	150	146	145	149	162	168	175	184	177	182	170	157	143	137	110	102
10	76	68*	68*	87	77	73	75	109	119	126	135	159	164	171	173	170	167	175	169	162	151	138	118	109
11	83	92	90	66*	88	84	77	80	102	154	164	162	171	170	177	182	178	200	183	179	170	156	142	132
12	127	105	83	78	65*	49*	70*	102	140	157	167	163	171	181	172	199	202	195	196	183	167	140	113	99
13	90	83	77	67*	64*	66*	77	106	138	173	188	202	205	215	226	231	232	224	228	210	199	176	166	154
14	145	130	123	118	115	97	86	119	165	178	196	217	227	232	243	246	252	263	258	241	225	204	189	184
15	161	158	164	157	159	152	160	157	170	180	189	182	184	164	177	186	182	184	181	180	171	167	161	156
16	154	153	153	137	137	138	134	135	142	144	160	164	172	177	180	185	187	189	189	188	183	178	161	153
17	146	148	160	156	152	152	153	152	160	175	182	198	204	219	205	204	218	224	225	220	204	186	171	172
18	168	177	179	174	175	169	166	176	196	214	228	236	253	270	278	272	271	258	263	258	246	218	202	196
19	197	192	182	178	174	166	166	186	206	225	246	264	276	294	302	302	302	303	294	259	265	240	226	215
20	185	174	179	192	189	166	172	182	204	232	261	272	280	296	299	307	314	315	310	283	272	248	237	214
21	217	212	196	201	186	166	157	151	200	223	238	249	261	268	274	283	282	279	269	264	241	239	220	204
22	190	183	172	190	182	173	180	172	164	164	170	176	196	213	212	226	235	243	217	203	195	186	179	175
23	178	172	168	157	155	146	139	147	166	194	207	226	238	253	256	257	264	266	262	250	232	208	205	188
24	178	174	164	152	166	146	140	150	181	200	219	232	251	266	262	267	269	268	267	260	232	221	214	207
25	201	194	187	179	177	169	162	182	189	196	218	245	266	287	315	305	297	295	232	163	164	161	158	150
26	147	154	153	146	142	138	136	141	151	158	168	178	186	197	205	204	204	199	196	196	182	170	164	160
27	159	150	146	143	137	131	128	128	136	147	156	161	171	180	187	194	188	187	183	174	155	119	91	73
28	68	56	46	45	33	30	21	40	104	137	146	149	152	166	177	190	191	196	191	182	166	151	164	156
29	152	147	142	138	136	128	130	137	149	165	182	204	228	238	245	245	242	225	216	210	201	193	192	189
30	189	186	183	180	177	165	164	161	166	175	193	206	234	230	248	259	257	247	232	213	204	200	188	171
31	175	172	173	163	157	159	161	157	157	153	150	138	135	128	129	128	118	115	113	113	106	106	105	102

*denotes temperatures used in chilling hours calculation

Table 1. 5 September, 1999 La Ronge Hourly Temperature Summary – Dry Bulb Air Temperature (0.1°C)

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	102	101	97	93	83	69*	61*	59*	57*	61*	69	79	89	98	112	116	111	106	99	98	91	82	80	77
2	77	73	75	73	55*	56*	55*	44*	82	102	124	134	144	150	161	172	160	166	157	150	130	121	107	97
3	96	87	83	74	82	73	76	90	109	131	153	180	190	196	189	200	183	177	193	161	130	102	84	77
4	77	63*	71	71	68*	51*	40*	53*	88	131	155	171	177	200	202	186	178	176	171	170	158	148	155	149
5	144	141	135	129	125	129	120	114	125	149	171	183	186	186	190	198	196	196	192	176	154	148	141	140
6	138	134	128	127	123	118	113	113	100	94	92	106	118	128	132	135	128	135	133	137	132	127	120	123
7	122	120	119	117	121	120	119	116	110	108	109	111	108	109	109	105	100	93	90	80	70*	64*	58*	59*
8	57*	63*	64*	66*	69*	61*	57*	62*	74	91	119	117	130	129	133	137	138	146	137	128	109	104	89	85
9	79	55*	67*	59*	57*	57*	45*	54*	80	99	123	145	148	159	166	169	176	183	166	145	116	84	68*	58*
10	44*	27*	31*	61*	66*	62*	47*	77	101	113	121	124	129	142	143	148	166	147	141	145	131	113	125	122
11	102	104	99	97	90	97	84	82	98	119	125	131	119	128	131	118	121	124	122	113	105	96	92	91
12	86	84	82	81	74	72	62*	53*	69*	84	91	103	114	107	120	110	122	98	99	93	80	79	74	65*
13	69*	76	77	78	81	79	75	60*	73	77	90	105	106	112	105	106	110	107	103	97	68*	51*	25*	13*
14	3*	3*	-3	-9	-11	-3	-14	-8	39*	76	112	134	148	156	161	166	173	171	166	149	129	121	109	93
15	88	85	80	71	75	71	69*	69*	109	135	156	171	192	202	217	225	228	230	215	190	147	122	109	110
16	132	146	135	130	120	110	108	104	113	126	135	148	153	166	181	196	198	194	182	183	179	176	164	158
17	151	144	138	147	138	132	133	136	126	121	123	128	145	151	160	161	176	145	142	121	112	98	101	101
18	81	78	75	74	73	72	73	72	77	67*	58*	51*	58*	62*	71	77	74	67*	64*	64*	62*	58*	56*	55*
19	48*	44*	41*	38*	37*	28*	30*	35*	41*	52*	57*	68*	85	84	81	83	88	88	86	83	83	78	69*	64*
20	62*	60*	56*	48*	45*	41*	42*	49*	61*	87	138	162	186	213	225	228	230	231	226	201	186	175	166	165
21	146	136	124	112	94	84	74	66*	82	107	135	158	174	186	198	204	199	188	182	160	137	138	127	136
22	140	139	125	114	99	83	61*	40*	54*	103	124	144	168	181	182	177	174	173	165	144	92	72	50*	51*
23	34*	19*	24*	14*	11*	22*	79	93	103	109	120	139	149	171	189	194	191	198	192	174	167	166	159	160
24	150	131	135	115	120	130	130	131	134	105	97	95	96	90	95	98	102	104	112	101	85	59*	79	72
25	78	73	70	70*	62*	55*	50*	47*	61*	88	102	115	131	146	148	140	136	133	139	111	88	75	76	54*
26	55*	51*	50*	32*	27*	-4	-6	-10	37*	65*	79	83	92	93	100	92	87	83	81	74	71*	67*	58*	41*
27	34*	11*	-5	-11	-7	0*	0*	15*	28*	47*	62*	87	93	88	87	104	110	119	109	92	88	77	65*	61*
28	56*	55*	57*	46*	36*	34*	20*	15*	15*	22*	32*	46*	53*	59*	63*	72	79	77	67*	56*	62*	56*	55*	65*
29	49*	58*	55*	60*	60*	64*	56*	51*	56*	56*	62*	62*	61*	62*	57*	63*	54*	44*	34*	41*	37*	21*	12*	8*
30	1	-1	0	-2	-6	-11	-18	-11	-17	-15	-9	0*	11*	13*	19*	19*	16*	13*	14*	9*	6*	8*	1*	0*

*denotes temperatures used in chilling hours calculation

Table 1. 6 August 1998 La Ronge Hourly Temperature Summary – Dry Bulb Air Temperature (0.1°C)

15	69*	81	82	86	84	108	115	121	122	130	144	151	169	180	198	196	195	184	176	173	141	116	111	99
16	98	88	85	75	72	69*	76	80	97	103	102	102	114	122	141	147	142	136	130	130	130	127	126	125
17	121	101	100	104	100	84	87	87	89	98	106	115	120	118	121	129	131	125	117	95	63*	27*	6*	-12
18	-15	-18	-20	-24	-32	-25	-10	-27	11*	69*	83	94	106	103	115	127	131	136	131	117	108	107	93	88
19	84	88	88	78	84	84	90	86	95	97	106	117	117	120	126	128	130	134	135	117	69*	44*	25*	19*
20	9*	8*	1*	-5	-6	-9	-19	-26	27*	68*	107	134	146	148	150	146	147	149	141	122	110	408	103	98
21	94	86	85	80	75	72	68*	51*	62*	77	100	128	135	157	166	170	171	171	162	144	137	126	109	104
22	104	89	77	75	83	82	67*	61*	74	99	125	129	158	180	190	197	195	184	172	151	124	113	101	100
23	77	45*	35*	26*	39*	33*	18*	24*	51*	79	103	126	135	142	140	143	145	148	138	113	94	98	113	113
24	106	105	107	83	86	89	87	70*	68*	102	109	118	129	119	117	93	84	86	84	77	69*	65*	62*	60*
25	44*	19*	7*	-7	-14	-16	-4	-24	-5	58*	73	80	91	102	97	112	114	111	104	79	32*	17*	79	72
26	70*	63*	55*	59*	48*	55*	60*	60*	48*	58*	71	72	78	81	85	85	95	92	91	72	65*	67*	80	84
27	82	77	55*	74	73	69*	60*	50*	62*	84	101	118	129	135	137	139	141	134	113	88	83	83	79	78
28	80	77	78	78	77	77	61*	65*	65*	70*	80	83	85	98	97	96	93	104	93	84	67*	66*	57*	38*
29	29*	18*	26*	47*	51*	51*	52*	47*	48*	56*	55*	66*	76	81	84	89	83	83	72	54*	49*	39*	36*	9*
30	43*	43*	38*	39*	40*	40*	35*	36*	37*	48*	49*	54*	58*	73	82	91	88	87	73	49*	14*	-10	-7	8*

* denotes tempertures used in chilling hour calculation

Table 1. 7 September, 1998 La Ronge Hourly Temperature Summary – Dry Bulb Air Temperatures (0.1°C).

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	84	86	72	74	62	48*	51*	55*	85	113	131	139	153	159	168	171	174	179	163	156	135	120	119	133
2	144	137	136	135	135	137	131	135	145	151	161	172	185	200	210	221	215	226	210	204	195	182	172	169
3	166	156	146	140	157	157	160	156	157	166	179	202	209	216	216	222	224	216	211	193	155	121	94	84
4	65*	62*	59*	70*	51*	58*	78	83	121	141	139	133	153	177	206	194	206	198	193	182	157	135	106	84
5	111	111	105	99	91	84	74	77	104	131	156	177	185	193	193	190	202	199	184	177	160	136	121	97
6	82	74	69*	60*	73	63*	49*	58*	96	127	142	149	163	178	174	186	189	188	179	156	127	92	105	130
7	135	129	127	124	120	113	112	117	125	132	145	162	169	183	207	203	211	209	202	188	177	171	166	167
8	158	152	149	148	147	149	147	145	141	144	146	157	158	165	159	164	186	184	182	175	164	152	129	107
9	98	90	95	96	98	108	116	117	119	120	126	136	147	168	186	205	20	206	196	182	172	165	147	142
10	139	136	135	130	131	132	132	132	132	139	151	166	171	182	192	199	192	190	192	171	134	128	132	132
11	121	115	115	108	99	88	82	82	105	123	143	171	175	187	196	205	203	195	186	178	178	174	167	165
12	152	152	151	143	136	130	119	110	127	146	159	184	187	202	202	212	218	211	205	183	138	106	99	84
13	94	125	132	129	135	134	139	142	155	174	177	182	179	182	208	203	190	184	189	181	162	152	140	128
14	113	109	107	102	93	92	106	84	97	101	124	136	133	140	134	152	146	142	143	122	111	79	69*	56
15	69*	81	82	86	84	108	115	121	122	130	144	151	169	180	198	196	195	184	176	173	141	116	111	99
16	98	88	85	75	72	69*	76	80	97	103	102	102	114	122	141	147	142	136	130	130	130	127	126	125
17	121	101	100	104	100	84	87	87	89	98	106	115	120	118	121	129	131	125	117	95	63*	27*	6*	-12
18	-15	-18	-20	-24	-32	-25	-10	-27	11*	69*	83	94	106	103	115	127	131	136	131	117	108	107	93	88
19	84	88	88	78	84	84	90	86	95	97	106	117	117	120	126	128	130	134	135	117	69*	44*	25*	19*
20	9*	8*	1*	-5	-6	-9	-19	-26	27*	68*	107	134	146	148	150	146	147	149	141	122	110	408	103	98
21	94	86	85	80	75	72	68*	51*	62*	77	100	128	135	157	166	170	171	171	162	144	137	126	109	104
22	104	89	77	75	83	82	67*	61*	74	99	125	129	158	180	190	197	195	184	172	151	124	113	101	100
23	77	45*	35*	26*	39*	33*	18*	24*	51*	79	103	126	135	142	140	143	145	148	138	113	94	98	113	113
24	106	105	107	83	86	89	87	70*	68*	102	109	118	129	119	117	93	84	86	84	77	69*	65*	62*	60*
25	44*	19*	7*	-7	-14	-16	-4	-24	-5	58*	73	80	91	102	97	112	114	111	104	79	32*	17*	79	72
26	70*	63*	55*	59*	48*	55*	60*	60*	48*	58*	71	72	78	81	85	85	95	92	91	72	65*	67*	80	84
27	82	77	55*	74	73	69*	60*	50*	62*	84	101	118	129	135	137	139	141	134	113	88	83	83	79	78
28	80	77	78	78	77	77	61*	65*	65*	70*	80	83	85	98	97	96	93	104	93	84	67*	66*	57*	38*
29	29*	18*	26*	47*	51*	51*	52*	47*	48*	56*	55*	66*	76	81	84	89	83	83	72	54*	49*	39*	36*	9*
30	43*	43*	38*	39*	40*	40*	35*	36*	37*	48*	49*	54*	58*	73	82	91	88	87	73	49*	14*	-10	-7	8*

* denotes tempertures used in chilling hour calculation

Table 1. 8

July, 1999 McArthur, CA for Hourly of Chilling at Fall River Nurseries, CA. Temperature Summary in C

Date	HR 00	HR 01	HR 02	HR 03	HR 04	HR 05	HR 06	HR 07	HR 08	HR 09	HR 10	HR 11	HR 12	HR 13	HR 14	HR 15	HR 16	HR 17	HR 18	HR 19	HR 20	HR 21	HR 22	HR 23
1	14.7	12.8	12.1	11.5	10.9	12.7	16.4	19.5	21.8	23.9	25.6	27.2	28.5	29.5	30.4	29.7	29.3	29.0	26.9	21.7	20.1	17.5	15.7	12.4
2	12.1	11.0	11.6	10.5	9.5	11.1	14.4	16.3	18.6	20.5	22.0	23.0	25.0	25.6	25.7	25.5	24.9	23.8	21.9	20.4	17.1	14.6	13.9	13.5
3	13.8	12.6	10.3	8.2	7.7	8.8	11.4	13.9	15.3	17.0	18.6	19.0	19.2	19.6	20.0	19.6	19.0	17.3	16.0	13.8	12.1	10.9	10.3	9.8
4	9.5	8.8	6.3	5.0	4.5	6.2	9.5	12.1	13.3	14.9	16.5	17.9	19.3	20.4	22.0	23.1	23.5	22.8	20.4	15.8	13.2	12.2	10.9	10.2
5	9.8	5.5	6.4	6.4	3.9	6.2	11.4	15.0	18.7	21.0	23.4	25.4	26.9	28.3	29.1	28.7	28.0	27.0	25.1	21.4	17.3	15.3	12.8	10.7
6	8.8	7.3	6.1	5.8	4.8	7.2	11.1	14.7	18.1	21.9	24.7	26.6	28.5	29.1	29.0	28.7	28.0	26.7	24.5	20.4	17.1	16.3	15.8	14.3
7	14.8	12.0	9.3	10.2	9.6	10.8	13.7	15.8	17.6	19.1	20.7	22.0	23.0	23.8	24.1	24.9	24.2	23.0	20.9	18.9	17.4	13.8	12.5	12.0
8	11.5	9.2	7.9	7.0	7.1	8.3	12.7	16.3	19.8	22.5	24.7	26.7	28.1	29.3	30.6	30.6	29.3	27.9	25.4	22.4	21.0	16.8	14.6	13.9
9	11.8	10.5	8.4	7.7	7.3	8.7	13.0	16.0	19.3	22.6	25.9	28.2	29.8	30.7	32.1	31.4	30.6	29.2	26.5	20.9	19.0	14.2	13.3	10.8
10	9.7	8.6	8.3	7.7	7.5	9.6	13.9	18.0	21.7	25.4	27.0	29.5	32.1	33.8	34.7	34.5	33.4	32.1	29.3	25.3	22.9	20.6	19.3	16.9
11	15.6	13.6	12.4	11.4	10.2	13.2	17.5	20.9	24.4	27.5	29.4	31.3	33.6	35.0	36.6	37.1	36.7	34.0	31.0	26.5	23.6	21.9	20.8	17.6
12	15.9	14.3	13.2	12.9	13.0	13.5	16.3	23.7	25.7	29.1	30.9	33.1	35.5	37.1	38.1	38.6	38.1	34.7	31.8	27.9	25.2	23.2	21.4	20.1
13	16.9	15.9	15.4	14.1	14.2	14.5	18.8	22.1	25.1	27.9	30.3	32.7	34.4	34.9	34.6	34.3	33.5	31.0	27.9	25.0	23.4	22.1	21.4	17.6
14	17.1	16.8	15.4	13.7	13.0	13.8	17.8	20.2	23.6	25.2	26.7	28.0	29.0	28.6	29.1	28.8	28.3	27.3	25.5	23.5	21.1	19.2	18.0	16.4
15	14.9	13.0	12.2	10.8	10.3	11.1	15.2	17.4	19.5	21.8	23.7	26.0	27.4	27.7	27.7	27.4	26.6	25.6	23.9	21.0	20.2	19.0	16.6	15.7
16	14.7	13.0	11.4	10.5	9.4	10.7	15.2	17.4	20.0	21.8	23.6	24.4	25.0	25.1	25.0	24.8	24.6	23.9	22.2	19.1	17.5	16.4	15.9	13.9
17	11.7	10.5	9.9	8.5	7.8	8.3	13.2	16.3	18.6	20.5	22.9	24.2	24.7	25.1	25.5	25.4	24.7	23.5	22.1	18.6	14.9	13.8	11.1	9.6
18	8.0	5.5	5.4	4.8	4.0	6.0	10.3	13.6	17.1	20.4	22.3	23.6	26.2	27.2	27.0	26.7	26.1	25.0	22.2	18.5	16.2	14.5	12.2	10.3
19	8.3	7.7	7.8	6.3	6.6	6.6	10.7	14.5	17.4	20.6	22.7	25.2	26.8	26.7	26.2	25.5	24.4	22.4	21.2	18.5	16.4	14.8	11.2	9.6
20	9.8	8.6	6.4	5.5	5.3	5.7	10.7	13.8	16.6	19.8	22.2	23.7	24.0	24.0	23.9	23.5	22.8	21.6	20.0	16.9	13.5	13.3	11.0	9.9
21	6.8	5.9	4.9	4.5	3.3	5.5	9.5	12.4	15.6	17.9	19.8	22.1	23.7	24.7	25.0	24.9	24.5	24.0	21.7	17.4	14.5	13.0	10.5	8.6
22	7.2	5.4	6.0	4.6	4.5	5.6	9.8	12.6	15.9	19.1	21.9	24.4	26.2	27.9	27.9	27.6	26.9	25.6	23.5	19.2	15.6	16.2	11.4	10.4
23	8.2	6.7	6.6	6.1	4.9	6.3	10.5	13.8	17.3	20.4	23.5	25.2	26.2	27.0	26.9	26.5	25.4	24.2	22.7	19.1	16.9	16.8	14.4	14.0
24	13.0	9.8	8.8	6.6	5.1	6.8	11.5	15.7	17.9	18.8	20.9	23.0	24.0	25.1	25.8	26.2	26.1	25.0	22.1	17.2	15.3	15.0	11.6	11.1
25	9.7	9.7	8.8	7.5	7.3	7.9	13.1	16.1	19.0	21.8	24.6	27.1	28.9	30.2	31.0	31.5	29.9	28.0	25.8	22.6	17.2	16.7	17.3	18.2
26	17.8	14.1	12.0	9.5	10.0	11.2	14.2	17.2	20.2	23.3	24.5	26.1	27.7	28.1	28.1	27.9	27.3	26.7	25.1	21.8	19.3	18.1	18.0	13.6
27	12.7	11.4	9.3	9.1	7.9	8.2	11.6	15.1	18.2	21.3	24.2	25.0	26.7	26.5	26.4	28.1	27.2	26.7	24.6	19.7	18.0	15.4	15.1	14.7
28	13.0	12.8	11.7	11.9	11.8	12.2	15.9	18.4	21.3	23.3	24.9	27.0	28.5	27.2	28.3	28.1	27.2	25.8	23.6	20.8	19.0	17.6	16.5	15.9
29	12.9	11.2	10.5	8.8	8.3	8.8	12.5	16.3	19.6	22.2	24.0	25.5	26.9	27.5	27.5	27.3	26.5	25.6	23.5	19.3	16.4	13.3	12.1	9.5
30	8.5	7.4	6.4	5.8	5.4	6.4	10.4	13.5	16.6	19.7	22.6	25.6	27.6	28.6	28.6	28.3	28.1	27.0	24.2	20.8	19.4	16.3	13.1	13.0